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SURGERY

A Monthly Journal Devoted to the Art and Science of Surgery

EDITORS
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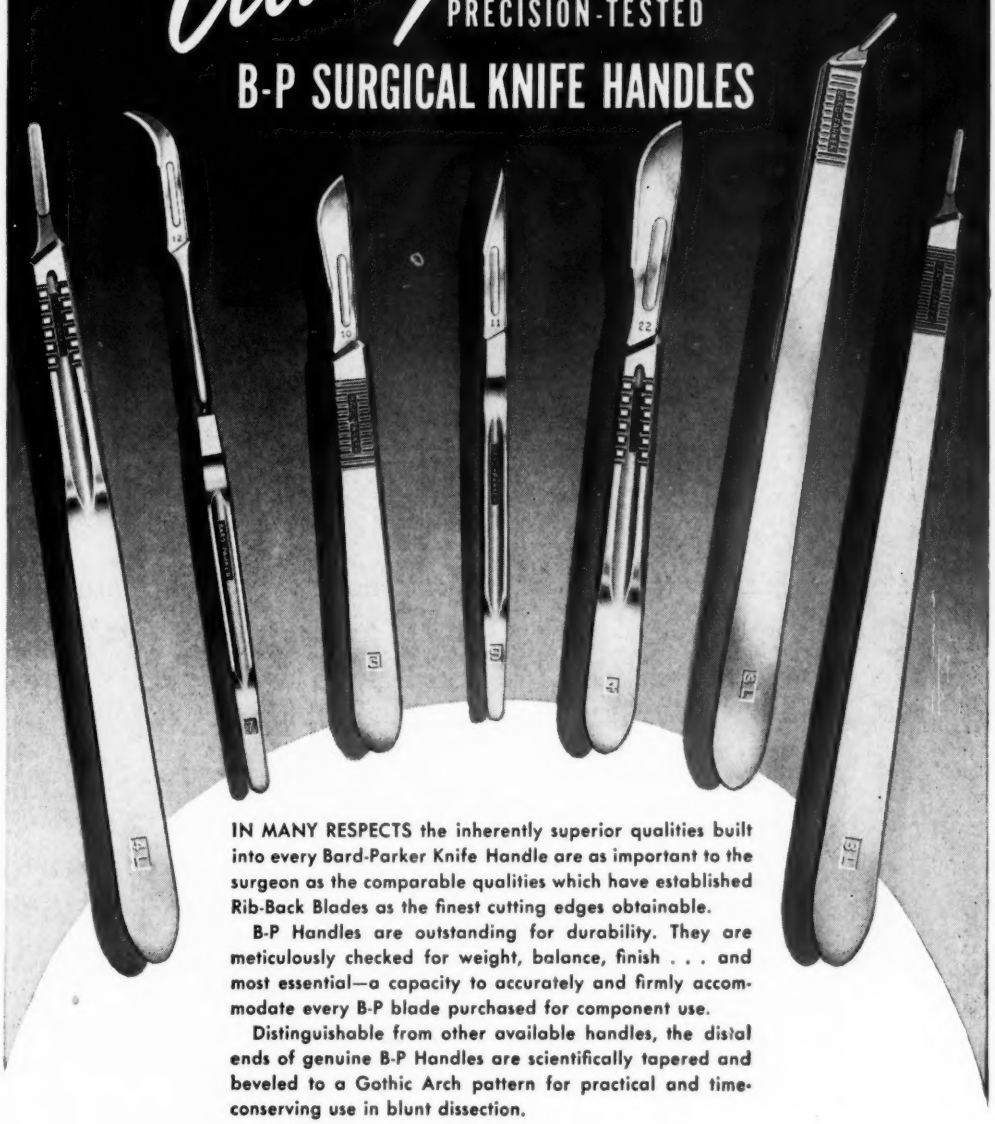

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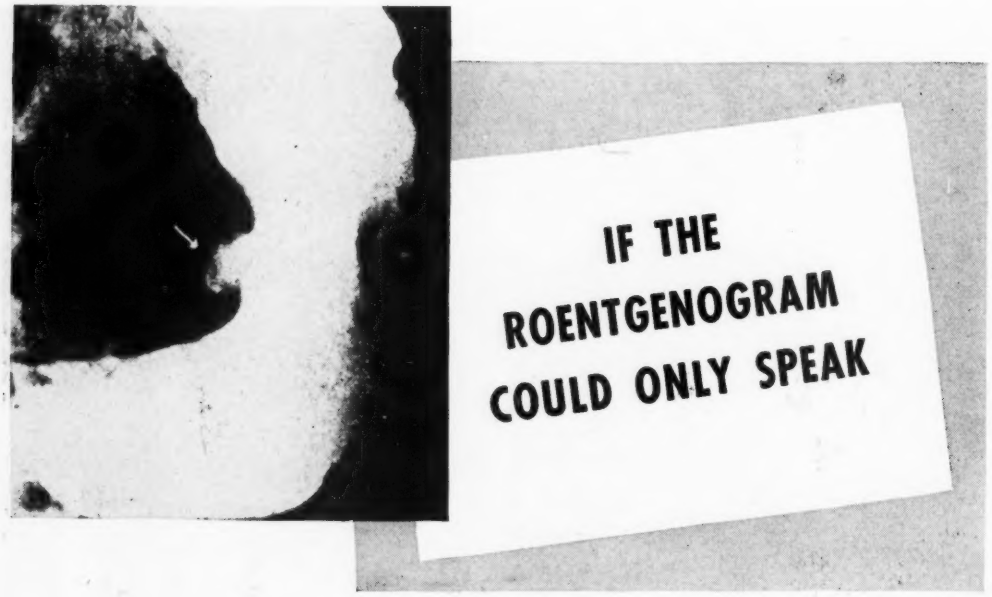

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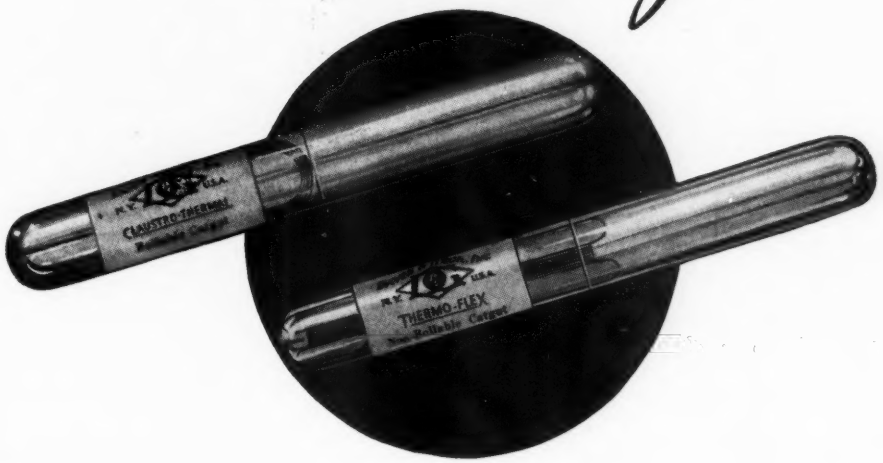

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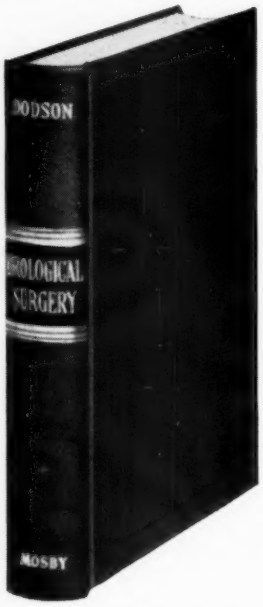

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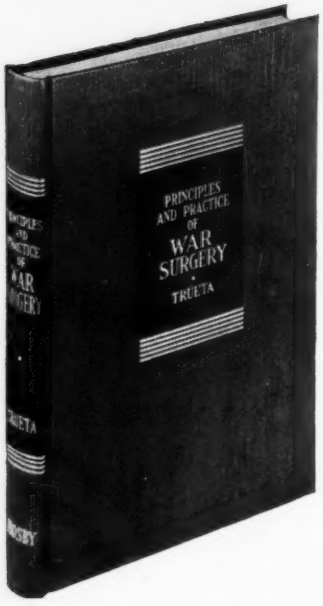

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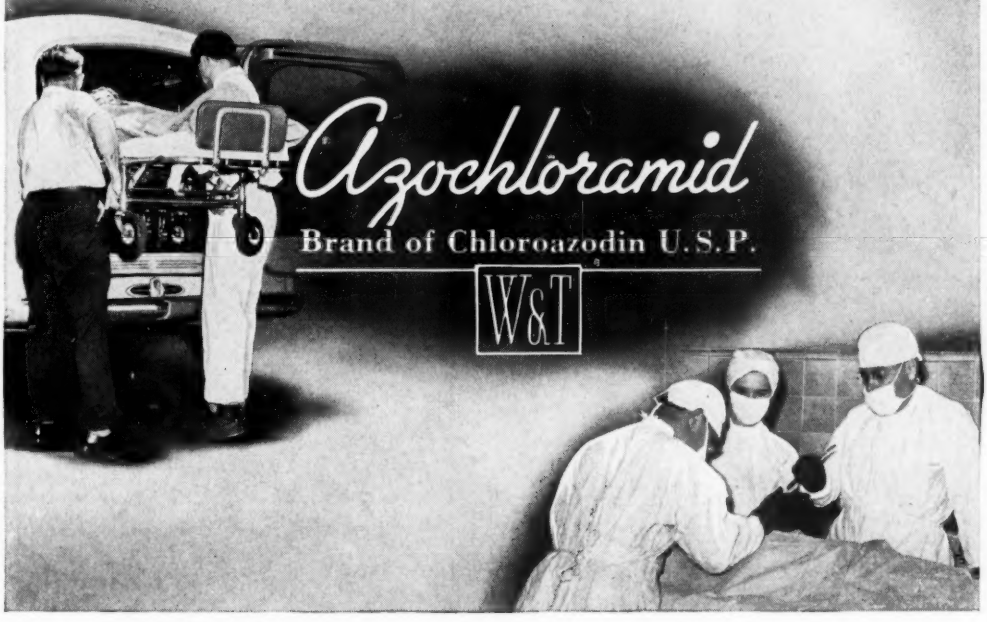

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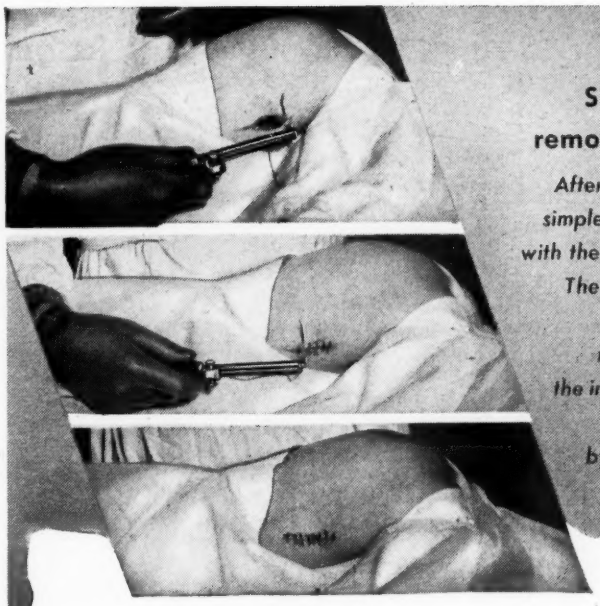

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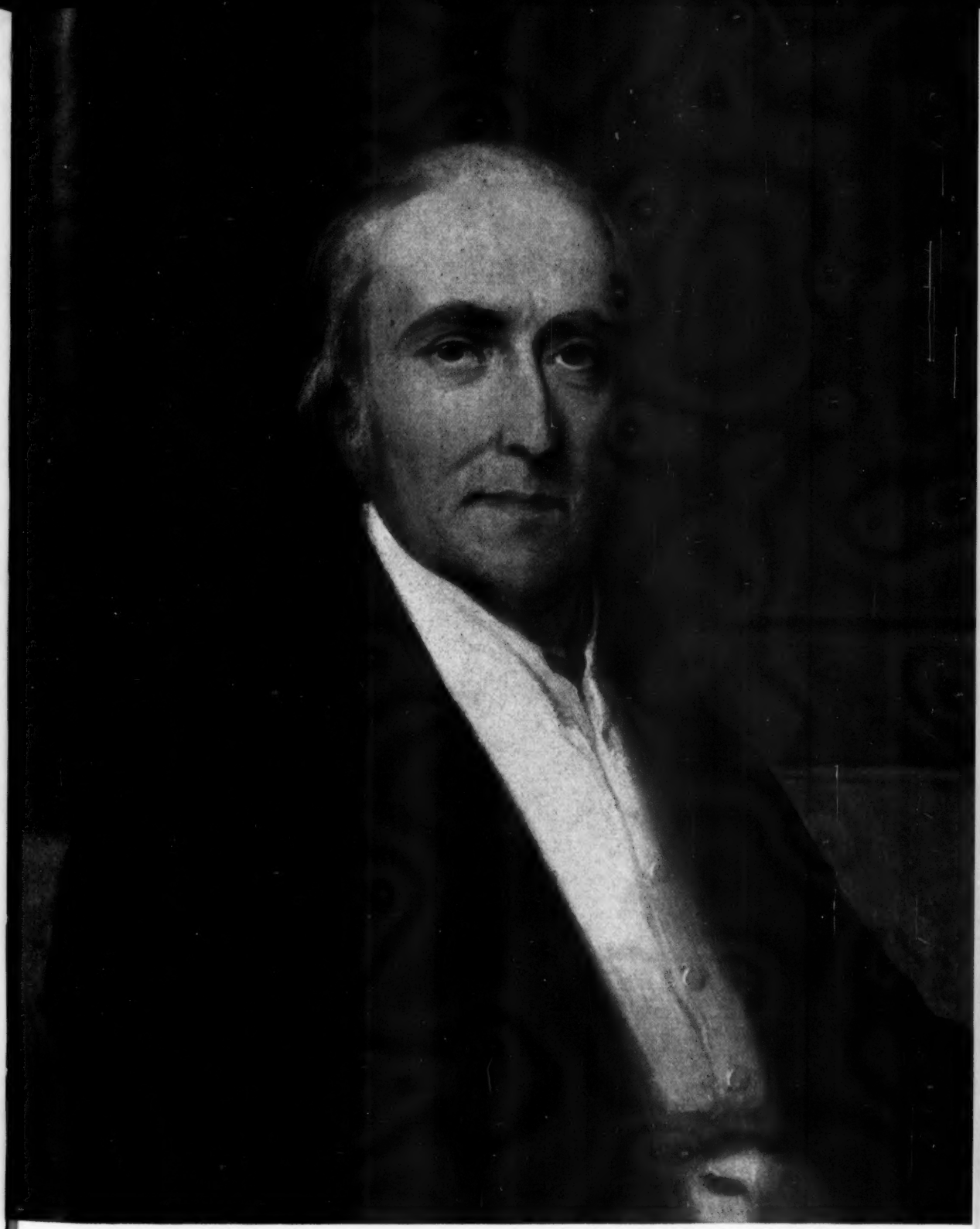

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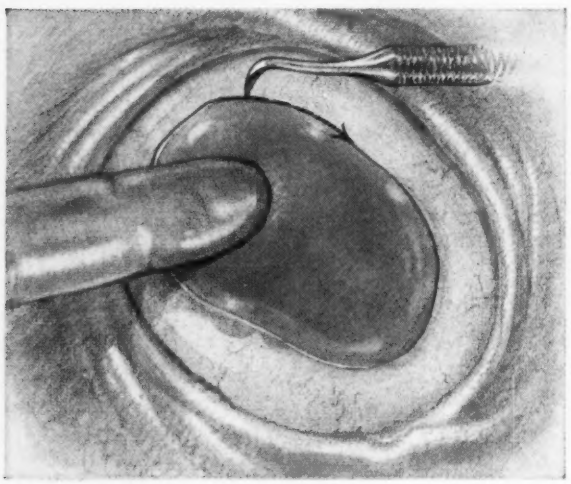

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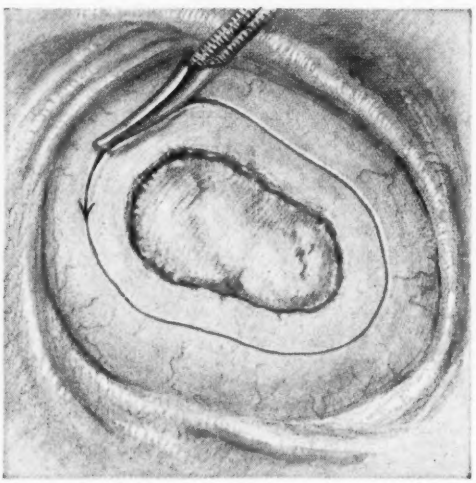

2. A lineator with cutting edge cuts the outer skull table, following the plate outline.

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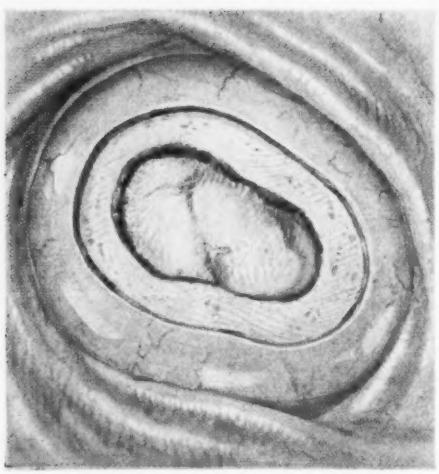
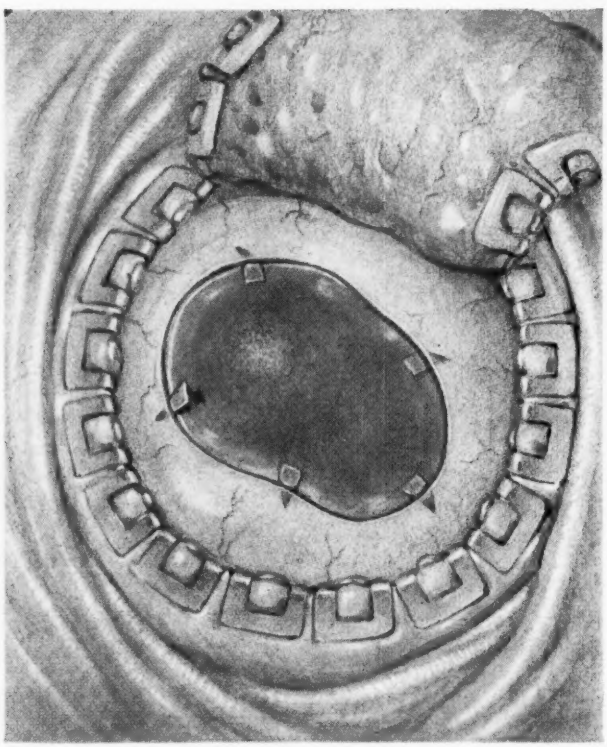


3. A shelf is formed by chiseling away a thin layer of outer skull table from edge of defect to groove cut by lineator.



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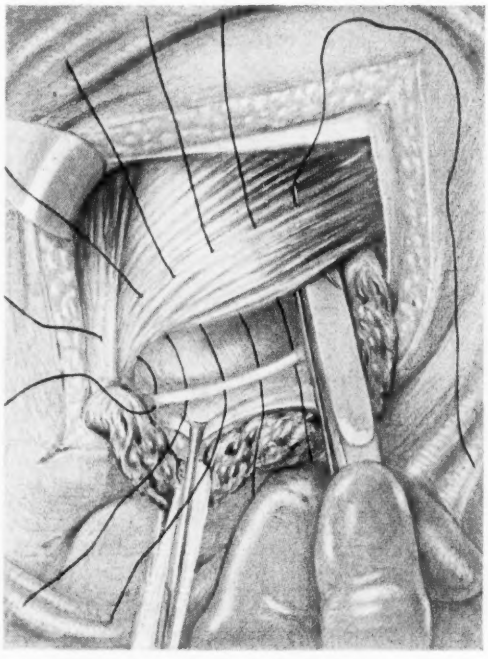

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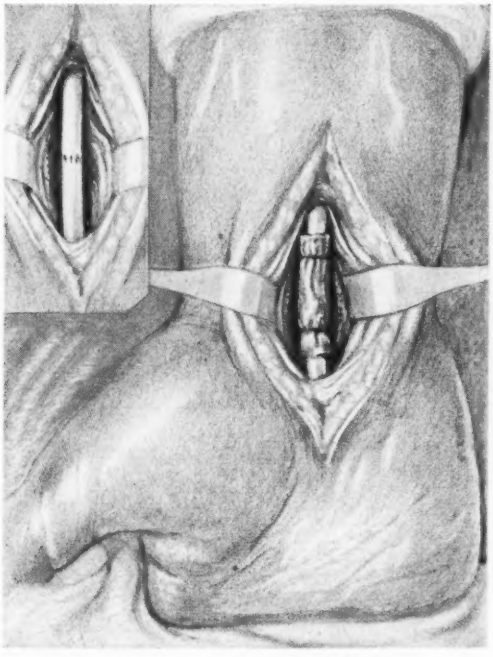

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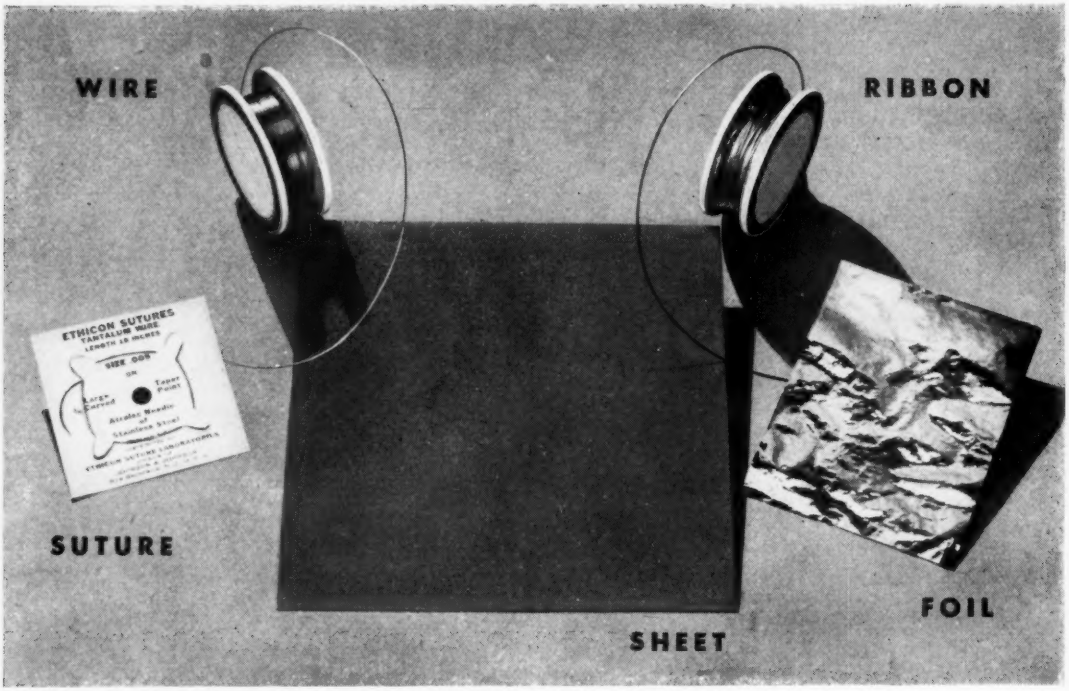

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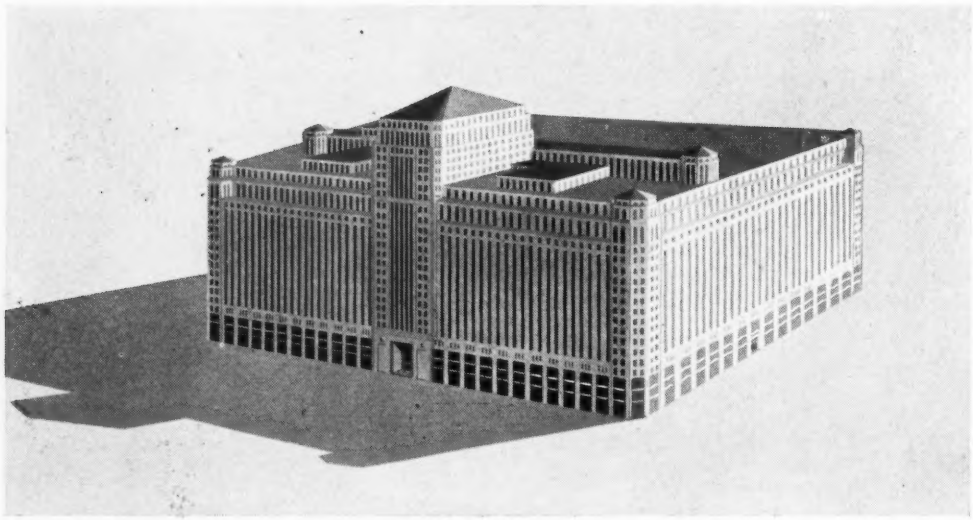

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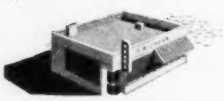

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Original Communications

THE PROGNOSIS IN ACUTE HEMATOGENOUS OSTEOMYELITIS WITH AND WITHOUT CHEMOTHERAPY

WILLIAM E. KENNEY, M.D., NEW HAVEN, CONN.

(From the Department of Surgery, Section of Orthopedics, Yale University School of Medicine)

INTRODUCTION

DURING the course of time, progress in the therapy of a disease is expected. Whether improvement has in fact been made rests upon the comparison of the results obtained in the present with those of the past.

It is reasonable to suppose that the addition of the sulfonamides to the treatment of acute hematogenous osteomyelitis may have altered certain features of this disease. Therefore it was deemed advisable to study various large series of cases reported in the literature both before and after the use of the sulfonamide drugs. In this manner a general standard for the past could be reached against which the results of treatment with the new drugs might be compared now and in the future.

Mortality is naturally of prime concern and the local result of secondary importance. Consequently, the previous prognosis will be presented from the standpoints of mortality and of disability. An attempt will then be made to compare the present picture with that of the past, special emphasis being placed on the methods of treatment: operative, supportive, nonoperative, and chemotherapeutic.

MORTALITY WITHOUT CHEMOTHERAPY

Without chemotherapy, the average mortality was 23 per cent. In Table I are listed the figures given by several authors for their respective series.

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TABLE I

AUTHORS	NO. OF CASES	OVERALL AVERAGE MORTALITY (%)
Pyrah and Pain[24]	262	27.1
Doran and Brown[9]	42	19.0
Fraser[11]	56	23.2
Crossan[8]	121	21.4
Findlay[10]	50	24.0
Mahorner[18]	112	25.2
Robertson[25]	337	22.0
Butler[6]	500	25.4
Penberthy and Weller[23]	67	22.8
Total	1547	

However, if these cases were divided into toxic and nontoxic, the average mortality for the former was 46 per cent. Toxic refers to patients with a temperature of 103°F. or higher, or to those with a high number of colonies of organisms recoverable per unit of blood. The standard varied somewhat with the individual reporting the series. Table II is illustrative of the findings of a few authors.

TABLE II

AUTHORS	NO. OF CASES	MORTALITY IN TOXIC CASES (%)
Mahorner[18]	60	50.0
Baker[2]	33	66.6
McCoy and Ross[21]	10	60.0
Beekman and Sullivan[3]	--	46.0
Crossan[8]	34	53.0
Brown[5]	77	33.6
Total	214	

It is to be noted that such figures approach septicemic mortality.

Certain features became clear with reference to the time of the operative procedure. Crossan[8] found that if operation were carried out within the first seven days of the disease, the mortality was between 34 and 39 per cent. It fell to 8 per cent during the eighth to the tenth days and to 0 per cent on the eleventh to the fourteenth days. It rose again thereafter. Wilson[27] reported a mortality of 25 per cent for those operated upon during the first seven days of the disease, and 9.7 per cent for the group treated operatively from the seventh to the twenty-eighth days. Mahorner and Crain[18, 19] pointed out that there was no mortality in their series if operation were performed within forty-eight hours of the onset of symptoms. However, there was a 35 per cent mortality during the third to the seventh days, and 13.3 per cent thereafter. A very significant additional observation was that there were no deaths if the patients had been hospitalized for four days before operation. This could be taken as an indication of the value of preoperative preparation. Beekman and Sullivan[3] found a 23 per cent mortality in a group operated upon within the first week of the disease and 8.9 per cent afterwards.

Consequently, it became clear that operation* in the first week of the disease was accompanied by a prohibitive mortality. Certainly it is plausible that before the seventh day the infection had not been sufficiently well localized to prevent an overwhelming septicemia following operative disturbance.†

Crossan[8] found that operation before the seventh day carried a mortality of 53 per cent if the temperature were 102° F. or more. Mahorner and Crain[18, 19] reported a 48.6 per cent mortality for operation before the seventh day on those with a temperature of 103° F. or more. These figures for the so-called toxic cases approach those of septicemia not associated with osteomyelitis.

On the other hand, even when the patient appeared extremely ill, operation after the seventh day yielded a mortality of 25 per cent (Crossan,[8] compare with 53 per cent) or of 20 per cent (Mahorner,[18, 19] compare with 48.6 per cent). This is evidence that before the seventh day the infection is not localized, and that *early* operation, especially upon either an unprepared or a toxic individual is dangerous.

Analysis was then made of the type of procedure performed. Drilling or guttering‡ the bone, whether such procedures were done as early or as delayed operations, seems to make little or no difference to the mortality percentages. (See Table III.) The severity of the disease in the individual patient does however make a striking difference. (See Table IV.)

TABLE III*

		NO. OF CASES	MORTALITY (%)
Crossan[8]	Immediate guttering	32	31
	Immediate drilling	18	33
	Delayed guttering	15	26
	Delayed drilling	14	28
	Total	79	

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This leaves an average mortality of 33.6 per cent for bone operations on toxic patients and a figure of 2.2 per cent for the same procedures on nontoxic patients.

Therefore, prior to chemotherapy, it was wise to delay bone decompression several days. This was in order (1) to restore the fluid balance, (2) to control the septicemia, (3) to allow granulation to wall off the osteomyelitic focus, and (4) to avoid a fatal septicemia as a result of operative interference.

*Except upon those who had received several days of preoperative supportive therapy.

†It is well realized that there may be a vast difference in time between the onset of symptoms and operation on the one hand, and the day of admission and operation on the other hand. In some series the former is used, in others the latter, and at times neither is given. The end results may be influenced by this time factor and therefore an attempt has been made in this communication to reduce all that are feasible to the duration between the onset of symptoms and the operation.

‡Guttering refers to that procedure in which a large amount of cortical bone is removed exposing widely the medullary cavity.

TABLE IV*

		NO. OF CASES	MORTALITY (%)
Brown[5]		*Toxic Cases*	
	Immediate guttering	35	31.4
	Immediate drilling	24	45.8
	Delayed guttering	8	37.5
	Delayed drilling	10	20.2
	Total	77	
Brown[5]		*Nontoxic Cases*	
	Immediate guttering	16	6.2
	Immediate drilling	9	0.0
	Delayed guttering	34	2.9
	Delayed drilling	6	0.0
	Total	65	

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LOCAL RESULTS WITHOUT CHEMOTHERAPY

Whether early operation were necessary for the later integrity of the bone was, and still is seriously questioned. Unfortunately authors have hitherto been so concerned with the mortality that little has been written comparing the functional results of early and of delayed operations. One of the strongest pleas for early intervention in order to avoid chronic osteomyelitis, persistent sinuses, recurrences, shortening, deformities, and limitation of motion of neighboring joints comes from McCarroll and Key.[20] In 200 cases of chronic osteomyelitis they found that only 9 patients had been operated upon within one week of the onset of symptoms. That most certainly indicates that the longer operation is delayed the more surely sequelae will occur. In a report by Harris,[14] of a small number of cases, healing took place in 13 out of 17 patients surviving early* bone decompression, whereas it occurred in only 1 of 12 survivals when operation was delayed until after the seventh day. Doran and Brown[9] stated that the majority of their patients receiving early care recovered within an average of four months. In fourteen patients treated by bone decompression within a few days of onset of symptoms, healing took place in an average of four months. Of twenty patients treated later than a few days after onset, healing took place in 14 and did not occur in 6. The average length of time for healing in these cases must have been much greater since for the whole series of 34 cases, the average time for healing was 11.4 months (in contrast to four months for patients getting early care).

In Butler's series,[6] bone decompression in 155 cases yielded complete healing in 55 per cent whereas draining of a subperiosteal abscess in 52 cases gave good results in only 41 per cent.

Such experiences prove not only the wisdom of bone decompression but also the desirability of such a procedure early in the course of the disease.

*That is within seven days of onset of symptoms.

It is reasonable to believe that the longer the infection is allowed to persist in bone, the greater the destruction, the more extensive the process, and the poorer the end result is likely to be. Therefore, if early operation could be performed with a low mortality, one should expect a better prognosis for the local lesion.

However, regardless of the time or type of operation, the overall end results before sulfonamide therapy, expressed approximately, were as follows: Healing took place in 50 per cent of the cases; metastasis occurred in 33 per cent, and sequestration in 33 per cent. About one-third of the patients had either lengthening or shortening of the extremity, limitation of motion, or ankylosis of the neighboring joint.

Many reported series include patients who were treated by incision down to bone alone, by aspiration alone, or by no operative procedure. The mortality for those (toxic and nontoxic) receiving incision alone without sulfonamide is 14 per cent (on the basis of 359 collected cases). Three hundred and nine have follow-ups which reveal that 181 (or almost 60 per cent) are unsatisfactory. Some had metastases, others had some type of disability, or needed sequestrectomy, diaphysectomy, or were unhealed. There is a striking difference in the end result as far as the bone is concerned between incision and that of decompression.

Patients treated with aspiration alone without chemotherapy had a mortality of 12 per cent. In a follow-up of 96, there were poor results in 47 or almost 50 per cent. Furthermore, of the 96 total, 41 had spontaneous drainage although this was not considered per se reason enough to classify it as a poor outcome. The end result is far from desirable although the small number of cases prevents any conclusions.

Consequently, the method most likely to offer a reasonable hope of avoiding disability is that of early operation in the nature of bone decompression. However desirable it may have been to use this method of therapy, the high mortality of early operation without the sulfonamide drugs prevented its adequate application.

MORTALITY WITH CHEMOTHERAPY

When the appropriate sulfonamide was administered systemically the average mortality fell from the previously found figure of 23 to 3.5 per cent. (See Table V.)

TABLE V

WHEN SULFONAMIDE WAS USED SYSTEMICALLY

AUTHORS	NO. OF CASES	MORTALITY (%)
Baker[2]	9	11.0
Penberthy and Weller[23]	19	0
Wilson and McKeever[29]	31	3.2
L'Episcopo and Hagerty[17]	27	3.7
Total	86	

Undoubtedly this represents a decided improvement in prognosis, inasmuch as the overall mortality fell to that of the nontoxic group without chemotherapy.

LOCAL RESULTS WITH CHEMOTHERAPY

Although sufficient time has not elapsed since the use of sulfonamides to allow an adequate follow-up on a large group of cases, the following facts are of some significance.

In a group of 47 patients treated by delayed bone decompression and by sulfonamide systemically, results in 18 were unsatisfactory.

L'Episcopo and Hagerty[17] reported a series of 27 cases; in 15 patients aspiration was done, in 4 incision to bone only, and 8 were untouched. They were treated by rest, soaks, and chemotherapy, in the main. In 5 drainage was spontaneously, 4 had exacerbations, and metastases occurred 4 times. Eight patients developed sequestrae, 1 had a pathologic fracture, and 4 had some functional impairment of adjacent joints. Therefore neither delayed bone decompression, simple incision, nor aspiration seem productive of good results even after the use of the sulfonamide drugs.

Bick[4] concluded that the sulfonamides had not altered the general course of the pathologic process in bone, the rate of recurrences, or metastases. Wilson and McKeever[29] were undecided as to whether chemotherapy favorably influenced the change in the bone. They felt that there were fewer examples of massive bone destruction, and that healing occurred more rapidly. According to these authors metastasis was about one-half as frequent as before the sulfonamide drugs.

Chemotherapy, therefore, has had as its major effect the reduction of the mortality by controlling the primary septicemia and that following operation. It has perhaps to a minor degree aided wound healing, and may prove in the future to have reduced the incidence of metastasis. It has had no appreciable effect on the bone. The greatest advantage of the sulfonamides, however, would appear to be that now early bone decompression can be performed safely. Certainly by the use of infusions, intravenous chemotherapy, and adequate sedation almost all patients can be prepared for decompression within twelve hours. Under these circumstances, a low mortality and a much better local prognosis can be expected.

It will be noted that the entity of acute hematogenous osteomyelitis in infants as described by Green and Shannon[12] has been omitted from this discussion. They have pointed out the differences in the disease in infants. Acute hematogenous osteomyelitis in infants is usually caused by streptococci. The bone is relatively soft. The suppurative process more readily penetrates into the soft tissue. Absorption of the necrotic bone and reconstitution of bone are more easily accomplished and the infection in general is better tolerated.

If such cases are included among the group occurring after infancy the general results may appear better than when staphylococcal osteomyelitis is considered separately. Consequently, a sharp division must be made between these two vastly different types of the disease. The process behaves not unlike a soft tissue abscess and apparently can be treated as such, that is, by simple incision of a presenting abscess. It remains to be seen through future experience whether these cases can be treated by drug alone and without operative intervention.

SUMMARY

The mortality in acute hematogenous osteomyelitis before chemotherapy was 23 per cent on the average, 46 per cent in the toxic cases, and around 3 per cent in the nontoxic cases. After sulfonamide the mortality was 3.5 per cent.

Previous to the use of the drug, early bone decompression was almost prohibited by the severe mortality. Yet early bone decompression yielded the best results from the standpoints of the later integrity of the bone and function of the limb.

Neither incision down to bone, aspiration, or withholding operation either before or after the sulfonamides has given as satisfactory results as early bone decompression.

The new drugs, by controlling the initial septicemia and that which may follow operative intervention, have now allowed safe, early procedures.

The sulfonamide drugs have not proved of value so far as the local pathologic process is concerned.

One must still depend upon operation for the best results.

This study has been based on the reported experiences of surgeons with 3,176 cases of acute hematogenous osteomyelitis.

Acknowledgement is gratefully made to Dr. Samuel C. Harvey and to Dr. Malcolm S. Eveleth, Department of Surgery, Yale University School of Medicine, for advice in the preparation of this report.

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EMBOLIC OCCLUSION OF MAJOR ARTERIES

JOHN T. REYNOLDS, M.D., AND FRANK J. JIRKA, M.D.
CHICAGO, ILL.

(From the Department of Surgery, University of Illinois College of Medicine; from the Surgical Service of Dr. Frank J. Jirka, Cook County Hospital; and from the Fourth Surgical Service, St. Luke's Hospital)

INTRODUCTION.—Failure to counteract the ill effects of embolic occlusion of major arteries may result in the loss of limb. In spite of the fact that these embolic phenomena usually occur as a complication of an already serious cardiac disease, opinion today favors early operative removal of the embolus if such a procedure is possible. Embolectomy is preferred because it may save the extremity and because the strain of this operation is usually less than that of amputation. Every means must be used immediately if the embolectomy is to be successful in preventing the loss of the involved limb.

Source of Emboli.—The most common causes of emboli large enough to embarrass the peripheral circulation are rheumatic heart disease, arteriosclerotic (or hypertensive) heart disease, and the heart disease following occlusion of the coronary arteries. These emboli orginate from mural thrombi which develop within the lumen of the heart. They occur concomitantly with a seriously decompensated myocardium or as a mural thrombosis whose nidus is laid down over myocardium infarcted by coronary artery occlusion. Emboli may form (see Case 7) from thrombi deposited on the intimal lesions of the great vessels. They may also form in arterial aneurysms and be swept into the periphery. "Paradoxical" emboli may occur.

Emboli of sufficient size to occlude major arteries are rare in the course of bacterial endocarditis. When they occur they arise from mural thrombi and are not valvular vegetations. Emboli from the valvular vegetations may indirectly lead to the formation of major embolic phenomena by producing pyogenic aneurysms which in turn give rise to peripheral emboli.

Circulatory Factors.—There is no information as to the factor or factors which initiate the scattering of emboli from a heart which has been fibrillating for a long time. Frequently the phenomenon is preceded and/or accompanied by physical exhaustion (Cases 13 and 16)

The heparin used in Case 8 was furnished by the Abbott Laboratories, North Chicago, Ill. All other heparin was furnished in the form of Liquaemin by Hoffmann-La Roche, Inc., Nutley, N. J., through the courtesy of Dr. Geza de Takats.

The Rhythmic Compressor used at the Cook County Hospital to administer continuous intermittent venous compression was made available to the authors by the courtesy of the Burdick Corporation, 737 North Michigan Avenue, Chicago, Ill.

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and/or infection (Case 13). The histories of these patients usually reveal a recent and severe change in some feature of the cardiac mechanism.

Many patients with severe myocardial decompensation are under hospital care at the time the peripheral emboli occur. Repeatedly the occurrence of emboli has been noted to occur concomitantly with a change of digitalis dosage. These patients often have been given intensive digitalis therapy in an attempt to bring about circulatory efficiency as rapidly as possible (Cases 11 and 13). There is frequent evidence of digitalis overdosage occurring prior to or synchronously with the development of an embolus (Cases 13 and 14). Some patients without decompensation may have had the digitalis dosage increased or they may have taken the drug voluntarily (Cases 2 and 6). This clinical observation of the tendency of digitalis to encourage thrombosis is supported by the recent experiments of de Takats, Trumpp, and Gilbert.

Patients with coronary artery occlusions may develop peripheral emboli without digitalis therapy. In this group the coronary disease itself has caused circulatory and contractile anomalies which are sufficient to give rise to emboli. Unrecognized coronary attacks may occur. In such cases diagnosis of disease other than cardiac may have allowed the patient to become falsely secure and his failure to rest may so tax the diseased myocardium that an embolus develops. There seems to be a tendency for such emboli to occur on or about the tenth day following coronary artery occlusion (Cases 3 and 8).

Nature of the Embolus.—The physical properties of the emboli are important for the final outcome of the disease. When small emboli are discharged, they usually lodge in small peripheral arteries, give rise to few symptoms, and may even remain undiagnosed. If they are followed by a large embolus, the peripheral gangrene which follows develops partly as a result of the large embolus and partly as a result of the smaller emboli.

Emboli are prone to lodge where the arterial lumen becomes smaller, that is, just above or at points of bifurcation. If the embolus is of such a nature that it does not further fragment, it remains at the point of impaction and gradually assumes the contour of the surrounding vessel. These emboli may be easily and completely removed (Fig. 1). However, if the embolus is forced into both branches of the bifurcating vessel so that it assumes a Y-like contour (Fig. 1), its removal is difficult even though the clot is compact and can be handled without fragmentation. It should be emphasized that complete removal of the clot in such cases is very important in order to assure every possible opportunity for collateral circulation to occur.

When the original embolus is friable, it frequently breaks up with liberation of numerous smaller emboli into the periphery. Gangrene is more frequently observed with multiple emboli than with a single embolus.

The Physiologic Aspects of Embolic Occlusion.—When an embolus lodges in an artery, the resultant pain is not due to stimulus to the intima. The pain usually does not occur simultaneously with the occlusion but develops some minutes later, usually following a period of paresthesia associated with a sense of cold in the affected area. Pain is present only when the occluded artery nourishes a predominantly muscular area and it is felt in this region. Lewis has suggested that the accumulation of muscular metabolites in the ischemic extremity is responsible for this pain.

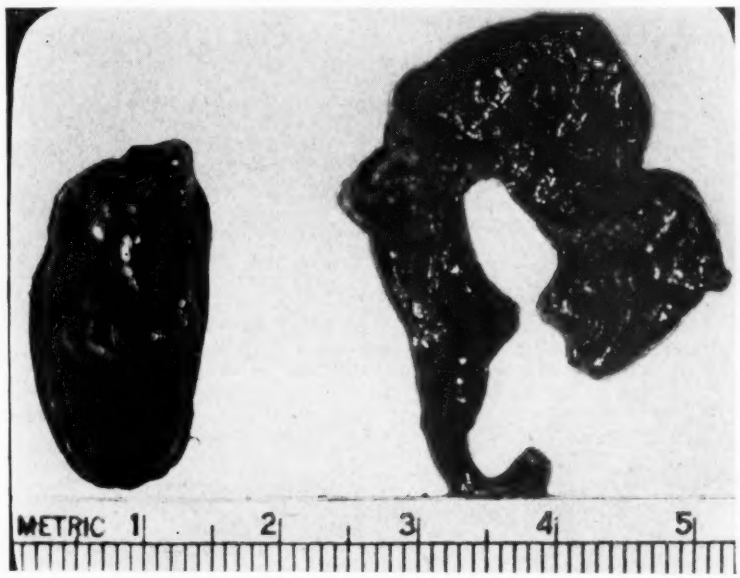

Fig. 1 (Case 16).—The smaller embolus on the left was removed from the right femoral artery. The folded clot on the left was extracted from the level of the bifurcation of the left iliac artery and had to be forcefully removed to allow the portion of the clot which blocked the external iliac to be freed.

The artery immediately peripheral to the occlusion is always in spasm by the time direct observation of the vessel is possible. Such a spasm may be considered beneficial when, for instance, an embolus lodges at the femoral bifurcation and is thereby prevented from migrating to the popliteal region. The spasm together with the occlusion of the major arterial trunk results in marked ischemia at the periphery. The only blood supply to the occluded areas comes by collateral routes or by oozing around the embolus. Under such circumstances blood is rapidly carried away by the open venous channels, causing a serious blood want. The circulation is drastically slowed and the constricted vessels are filled with a column of blood at low pressure, which probably

is also exposed to increased amounts of thromboplastic material. This column of blood distal to the embolus is likely to clot, thus producing a thrombosis into the periphery from the original embolus. Under these circumstances the column of clotted blood distal to the embolus is called a tail thrombus. This clotted blood is limited to the lumen of the large artery just distal to the embolic occlusion. It may be extracted at the time of embolectomy if it has not extended into so many branches that it is thereby fixed in place or if it has not become so large that it has become adherent to the wall of the artery (Figs. 2, 3, and 4). Later

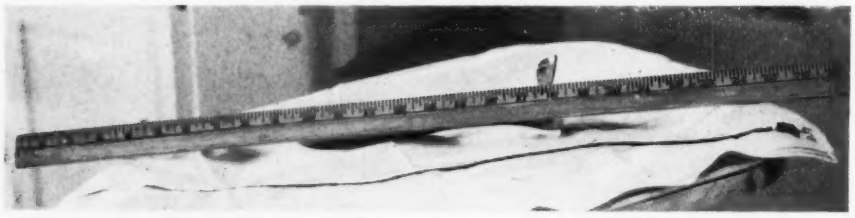

Fig. 2 (Case 6).—Embolus and tail thrombus removed. Note the length of the tail thrombus which, however, had not yet filled the arterial lumen.

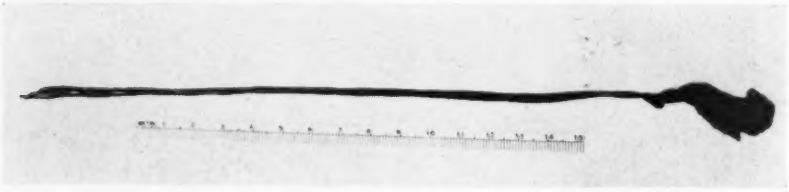

Fig. 3 (Case 20).—Embolus with tail thrombus. Note the greater diameter of the tail thrombus as compared with that in Cases 16 and 6.

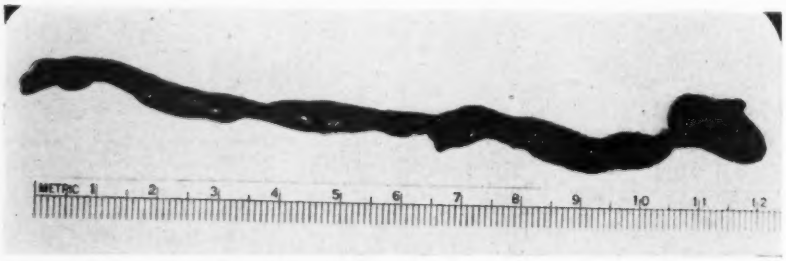

Fig. 4 (Case 19).—Note that the tail thrombus is about as large as the arterial lumen (as judged by the diameter of the original embolus at the right). Although the limb from which this thrombus was removed recovered, it is probable that if embolectomy had been delayed the entire arterial tree would ultimately have been plugged.

this process extending into the finer vessels may prevent any effective quantity of blood from reaching the periphery. When this has occurred, attempts to restore the circulation are obviously in vain and it is to the prevention of this phase of the process that therapeutic efforts are directed.

Clinical Picture.—The patient with a typical arterial embolus presents the initial symptom of paresthesia distributed in the area below the arterial occlusion, followed by a sense of cold and finally rapidly

developing pain distal to the occlusion and referred to the muscle area nourished by the vessel. This pain, which may be agonizing, is constant and is relieved by narcotics (occasionally by 100 per cent O_2, Rhoades). It is characteristically more severe when a large amount of muscle tissue is rendered ischemic, as occurs when a leg is involved, and less so when a smaller amount of muscle is involved, as in the arm. The paresthesia and sense of cold do not usually cause the patient to complain since they are rapidly succeeded by pain of such a degree that the patient seeks help. Pallor and a loss of peripheral motor power occur rapidly. This clinical picture is usually apparent within one-half an hour.

Fig. 5 (Case 6).—Photograph taken one hour after embolectomy of the right femoral artery. The pallor of this leg is still visible although less than it was preoperatively. The pallor is in contrast to the mottled appearance of the left leg which developed an embolus twenty-four hours previously. Neither of these limbs can be judged as beyond recovery by the appearance.

It should be emphasized that pain is not present over the embolus during the early stages of the process (Case 22). An embolus becomes tender only after arterial inflammation occurs about it. Although the length of time required for this to develop varies, it usually does not develop for several days.

When emboli move from one position to another, there is a change in the clinical picture, and pulses, previously closed, may be found to be open. Occasionally reflex arterial spasm may simulate embolic occlusion. This is usually recognizable when an artery previously not pulsating is found to be actively pulsating. Sometimes small peripheral emboli initiate immediate mass vasospastic phenomena which disappear spontaneously. Patients are seen in whom both femoral arteries are pulseless and the legs cold and useless; within a short time there may be complete regression of symptoms with no residual signs. On such an occasion the lack of pulsation originally noted must be interpreted as being due to spasm, since it is difficult to visualize an embolus large enough to occlude the aorta which would pass into the peripheral circulation without occlusing a major vessel.

It may be necessary occasionally to differentiate between arterial embolus and a spontaneous arterial thrombosis. In the latter, the presence of long-standing arterial disease (intermittent claudication syndrome) may indicate the nature of the lesion. There also may be a question of differential diagnosis when acute thrombophlebitis of the femoral or iliac vein occurs with great rapidity. Unless there is a pronounced associated arterial spasm, this is not difficult.

Therapy.—When the diagnosis of arterial occlusion by embolus is made, the immediate and most important therapeutic objective is to restore the circulation. This is best done by preventing a thrombosis from occurring within the arterial system distal to the embolus until the removal of the embolus can be carried out, which should be done as rapidly as possible. Since occlusion of the terminal arteries and arterioles by thrombosis peripheral to the embolus may render all subsequent therapeutic efforts futile, heparin should be administered at once to arrest progressive arterial thrombosis. Operative intervention must then be considered.

Anticoagulants: In the last six patients of our series, heparin has been given preoperatively. In two of these, a tail thrombus was found. The removal of clots from the iliac bifurcation in these patients required that the vessel be open and subject to manipulation for about twenty minutes. At no time did thrombosis occur at the operative site in contrast to previous operations in which heparin had not been used. Contrary to what might be expected, the use of heparin was not associated with troublesome bleeding from capillary ooze. Small vessels were secured with ligatures and the incision in the arterial wall stopped bleeding with promptness when sutured.

Relaxation of Arterial Spasm: The relief of the arterial spasm that accompanies embolism has been the object of a variety of therapeutic procedures. It has become routine to give antispasmotics as soon as diagnosis is made, and papaverine may well be given at the same time as is the heparin. Papaverine does not produce as profound a release of spasm as does sympathetic block. Relief of the arterial spasm has played an important part in the therapy because the spasm has been considered to be undesirable. It is our opinion that the release of arterial spasm by sympathetic block may allow the embolus to pass from a major artery where surgical intervention is practicable into a peripheral artery or arteries where removal is no longer possible. This occurred in one patient (Case 9) in whom the spasm was apparently released by the spinal anesthetic used. The original occlusion was present three inches below the inguinal ligament. After the anesthetic was effective, exposure of the artery at that point showed it to be patent and pulsating. An embolus had undoubtedly moved into the popliteal region since the patient required an amputation for the gangrene of the foot which followed. Had this embolus been removed while in the

femoral artery, her recovery might have eventuated. In another patient (Case 13) the embolus descended from the aortic bifurcation to the femoral and iliac arteries after sympathetic block. Fortunately the embolus did not continue into the popliteal region.

It is our opinion that sympathetic block should not be done preoperatively in embolic occlusions of the aorta or iliac or femoral arteries, where direct or indirect access to the occlusion is relatively easy. For the same reason spinal anesthesia should not be used. Although sympathetic block has reportedly given considerable relief of pain, the risk of loss of the embolus makes preoperative administration of narcotics a wise method of securing analgesia.

Removal of Embolus.—There are two major contraindications to early embolectomy. The first is related to the physical condition of the patient. For instance, a major operation such as the abdominal approach to the aorta or iliac vessels may be so formidable that it is unsafe. The use of a general anesthetic may impose too great a risk on the patient (Case 4). A position on the table which entails considerable effort in breathing, such as the prone position required for popliteal exploration, may be more than the patient with cardiac embarrassment can tolerate. Occasionally even the manipulation required to administer a sympathetic block will be excessive, as in Case 3. In these cases only such therapy as will not tax the physical reserves of the patient may be used. Fortunately, however, patients are rarely too ill to tolerate the simple approach to the femoral artery and frequently through this approach iliac and aortic occlusions may be reached and relieved.

The second contraindication to early embolectomy obtains when the arteries occluded are so small that closure of an arteriotomy wound would obliterate their lumina. Such arteries usually supply fields with rich collateral. Hence embolectomy of the tibial, radial, and ulnar arteries is unnecessary. Because of the rich anastomosis about the shoulder, embolectomy of the axillary and brachial arteries should be considered only after heparin and sympathetic block have proved inadequate as measured by ability to use the muscles of the forearm. When popliteal emboli occur, if they have not resulted in the loss of motor function of the calf muscles, the outcome is likely to be good. Central thrombosis in the artery may extend high enough to obliterate the collaterals which are supplying the calf. This occurred in two patients (Cases 14 and 23). For this reason heparin must be given when nonoperative measures are used as well as an adjunct to embolectomy.

After the diagnosis is established, heparin should be given and embolectomy should be performed as quickly as possible. It usually requires from two to three hours to corroborate the diagnosis and prepare for operation. Embolectomy after longer periods may be successful. In one patient (Case 1) the operation was performed twenty-seven hours after an embolus had lodged in a severely arteriosclerotic

femoral artery. It was removed satisfactorily and the limb was saved, using intensive intermittent venous occlusion. No heparin was available for this patient. (Atlas reported recovery of a patient operated upon sixty hours after an aortic embolus.) Another patient (Case 8) was seen twenty-four hours after an embolus had occurred. Because color of his leg improved suddenly and markedly, indicating a movement of the embolus with the development of probably adequate collateral circulation, he was treated with heparin, intermittent venous compression, and sympathetic blocks. For a week there were still no signs of gangrene, but it eventually developed ten days after the embolus (Figs. 6, 7, and 8).

Fig. 6 (Case 8).—This foot is beyond the possibility of recovery as judged by its appearance. Note the blebs and particularly the discoloration which is not due to circulatory stasis.

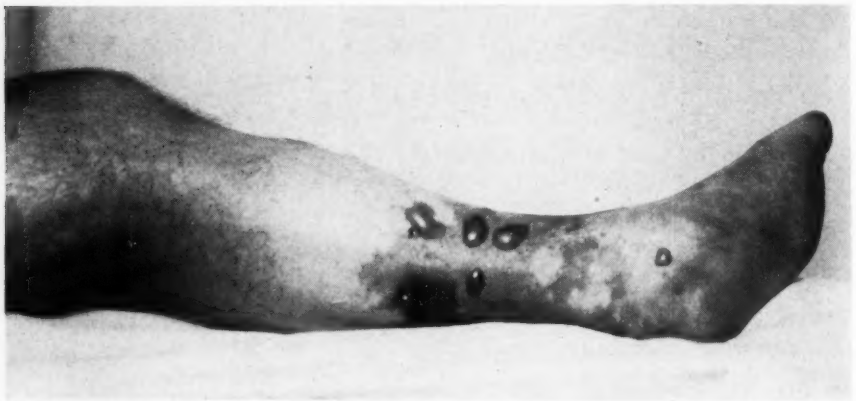

Fig. 7 (Case 8).—The blebs on this limb are particularly noticeable.

Operative Technique.—Because of the patient's condition the simplest procedure which will secure satisfactory results is preferred.

The majority of emboli occur in the femoral and iliac arteries or at the aortic bifurcation (de Takats), and the preferred operative procedure in all three situations is similar. Determination of the position of the embolus is simple. When the occlusion is above the inguinal liga-

ment, no pulse is felt at the ligament or below. When the embolus has lodged at the bifurcation of the femoral artery, the pulsation of the common femoral may be palpated even through the adipose tissue of obese patients. Below this level oscillometric readings readily locate the site of the occlusion. There is a characteristic exaggeration of oscillations just above the site of occlusion (Fig. 9).

After administration of heparin, the incision is best made parallel to the artery, and the abdomen is left exposed for extension. Provisional ligatures are placed about the artery above and below the site of arteriotomy. The incision should preferably be made below the largest part of the distended artery, so that the blood pressure may force the embolus out of the incision. The disadvantage to an incision so placed is that the lower end of the incision may be over the part of the artery already narrowed by the origin of the profunda. The advantage lies in making

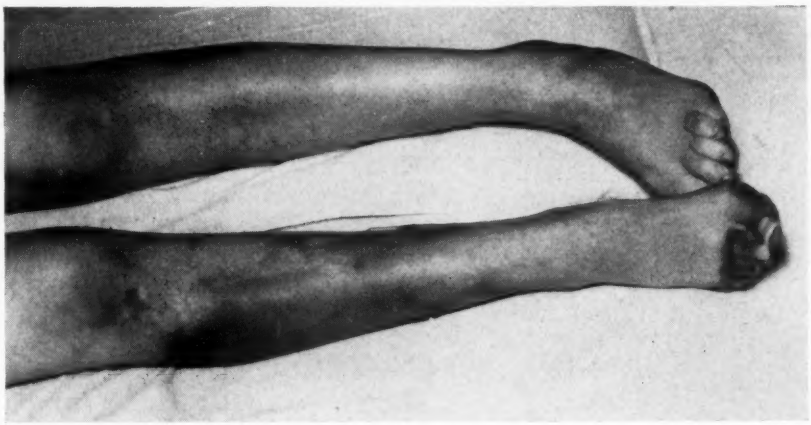

Fig. 8 (Case 13).—The right leg is beyond recovery. Note the dry gangrene of the toes and the patchy appearance of the anterior portion of the leg. This difference in viability of the leg is sometimes very distinct if one of the tibial arteries is closed and the other is open.

the incision into unaltered arterial wall. An incision so placed allows the removal of the tail thrombus, to be accomplished before removal of the main embolus. Removal of the tail thrombus would be difficult in the presence of a partially restored circulation. When the occlusion is above the level of the femoral bifurcation, the preferred site for arteriotomy is the common femoral artery at its broadest point, above the bifurcation, because closure of the arteriotomy will cause least narrowing of the lumen. Both provisional ligatures are then above the site of the major branches. Retrograde bleeding is thus more easily controlled. The distal artery is also kept closed to prevent fragments of emboli from passing down into the terminal branches.

If no blood flows from above when the artery is opened, it is assumed that the occlusion is below the iliac bifurcation. When a slow pulseless stream is seen, it may be due to retrograde bleeding by way of the iliac or epigastric arteries or to incomplete occlusion of the artery by the

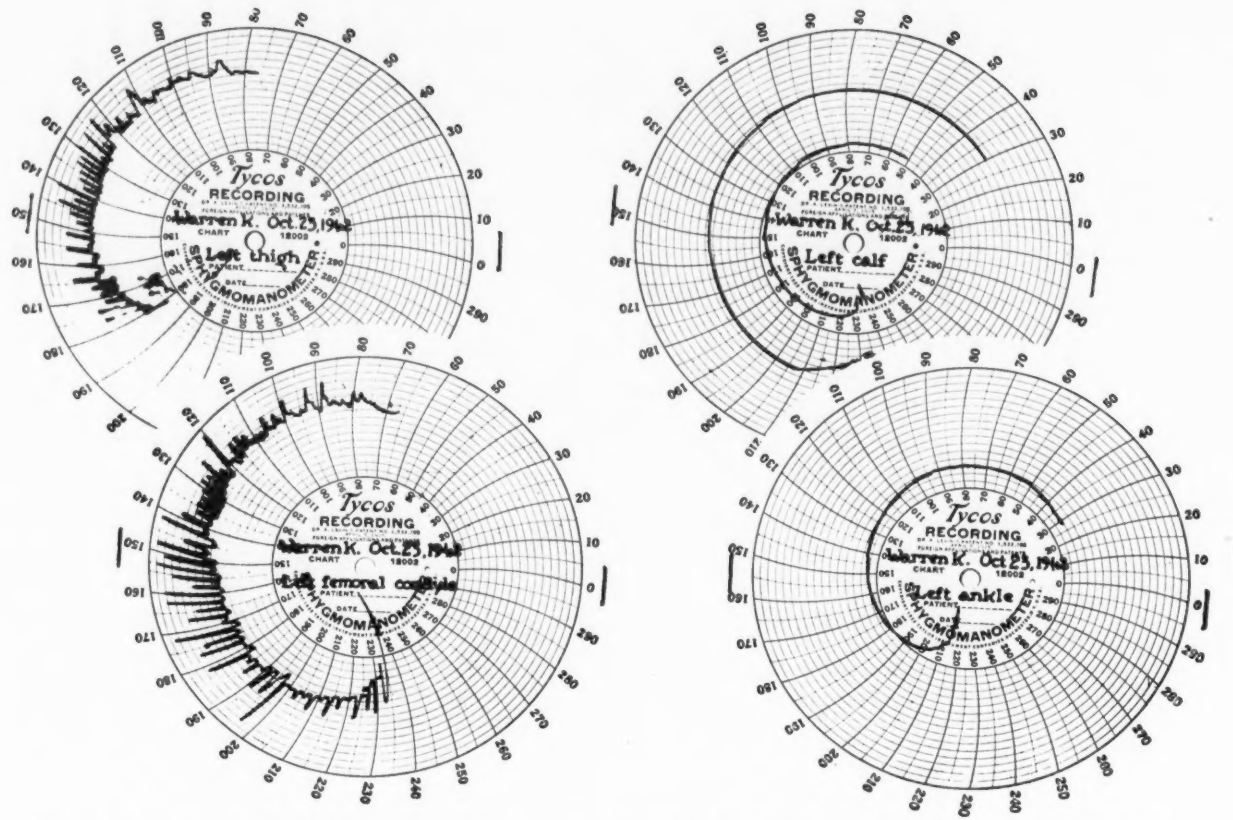

Fig. 9 (Case 2).—Oscillometric tracings taken on the day of occlusion of the left popliteal artery. Note the exaggerated oscillation of the artery just above the level of the occlusion and the absence of oscillation in the leg below it. See Fig. 11 for tracing taken fifteen months later.

embolus. In our experience the removal of the embolus from the region above the incision has not been easy. In one patient (Case 2), operated upon by Dr. de Takats, the first embolus in the left iliac artery was brought down by retroperitoneal arterial massage. In another (Case 11) the lowermost portion of the embolus was seen at the inguinal ligament and was grasped with gallstone forceps and extracted. The same procedure was used in Case 10. In Case 4 an actual incision into the iliac artery was used; the embolus was not obtained through the original incision and another higher incision was necessary. Subsequent experience would probably allow such an embolus to be removed through one incision, and that in the femoral artery. In Case 13 the right iliac was occluded at the level of the bifurcation; probing, passage of catheters (with and without suction), and milking failed to dislodge the embolus. The artery was in great spasm several times during the attempted embolectomy. This spasm was so great that it was hoped that the diagnosis had been wrong and that arterial spasm was the underlying pathologic change. However, there was no relief of circulatory obstruction by sympathetic block, and the leg became gangrenous. A patient (Case 16) whose left iliac was occluded in practically the same way was satisfactorily freed of the embolus when a gallstone probe was passed above the embolus, turned, and pulled down. The same procedure was used on two other patients (Cases 19 and 20). This maneuver apparently was successful because when the blunt end of the scoop which had been passed above the embolus was turned and removed, it engaged the embolus and pulled it out of the internal iliac where it was tightly wedged. The end of the scoop must not engage the arterial wall at the point of bifurcation when the clot is pulled out (Fig. 10). The same precaution applies to the use of any rigid probe with a knobby end. The possibility of pushing an embolus up to a bifurcation with resultant embolization of the other artery should not be forgotten.

In our experience the use of suction has not been successful, since it is impossible to apply the suction force directly to the embolus. Although we have had no experience with embolectomy on aortic occlusion, we would assume a similar difficulty.

Direct exposure of the iliac vessels with general anesthesia may provide satisfactory exposure. One patient (Case 4) was treated satisfactorily by embolectomy through an incision directly into the iliac vessel. However, this required a general anesthetic, and the death from "cardiac collapse" may have been influenced by such a major procedure. Subsequent iliac embolectomies have been successful using the femoral artery.

Free massive pulsating hemorrhage should be obtained before closure of the wound.

The suture material should be fine and nonabsorbable. Silk or cotton, preferably waxed to prevent cutting, has been used in the patients re-

ported here. Several autopsy specimens have revealed patent arteries at the site of incision.

The question of vein ligation at the time of embolectomy is a controversial subject. In the present series of cases concomitant vein ligation was performed nine times. In one patient (Case 11) marked redness and cyanosis of the leg occurred in the immediate postoperative period, but since the patient died in five days from the cardiac condition, it was impossible to correlate the vein ligation, the color of the leg, and the

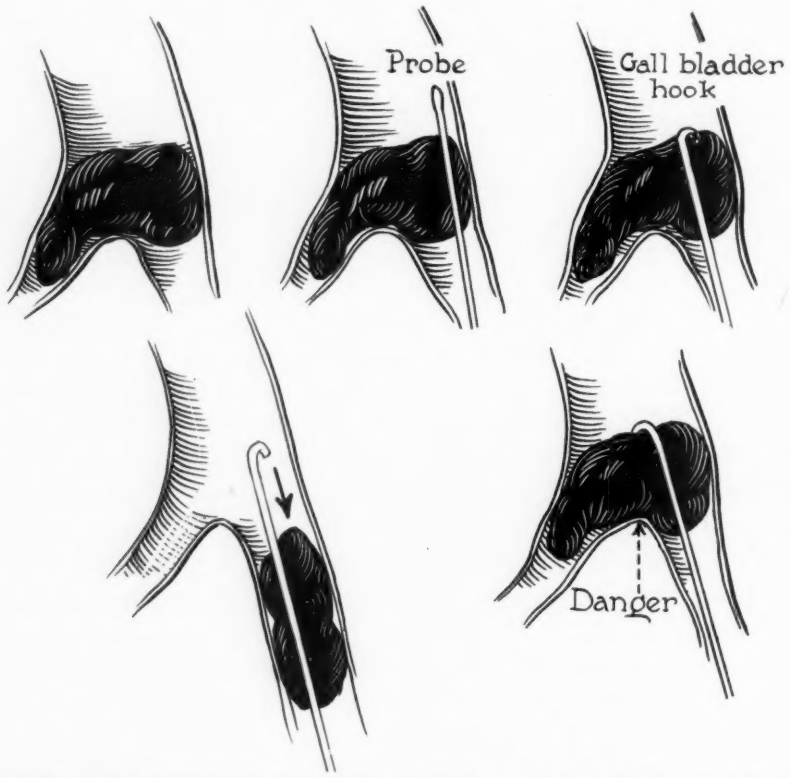

Fig. 10.—Illustration to emphasize the maneuver used to extract a clot from an artery where the clot has become wedged into the bifurcation and where the arteriotomy has been done below the level of the clot. Note that the end of the probe must be above the clot before it is turned and pulled down. Note also that the probe must be turned away from the direction of the major proximal branch.

final result to the limb. In seven of these patients the limb showed apparent total recovery as far as circulation was concerned, although six died in the immediate postoperative period. Only three required amputation and one of these developed inadequate circulation only very slowly after embolectomy (from seven to ten days). In the patient reported in Case 16, one vein was ligated and the other left unligated. After thirty-six hours, when she died from cardiac failure, both legs were equally warm and total recovery had apparently occurred. Thrombosis central to the ligated vein has not been seen. In our most recent cases vein ligation has been used only if there was serious doubt as to the

effectiveness of the arterial embolectomy. If the toes were not warm and the pulse had not returned and the patient still had considerable pain in the leg, the vein was ligated. This procedure follows the practice of Dr. Barney Brooks.

At the end of the operation the coagulation time should be determined and enough heparin given to bring it up to fifteen minutes, and heparin should be continued in dosages sufficient to maintain that coagulation time. Fifty milligrams of heparin every four hours have been found adequate to keep this level, although larger quantities may often be required. Smaller dosages have failed. The antagonistic action of digitalis to the heparin effect may require adjustment of heparin dosage.

We have recently used dicumarol to supplement and supplant heparin because of the large amounts of heparin needed to maintain proper coagulation time. Dicumarol dosage has been as follows: 300 mg. the first day, 200 mg. the second day, and 100 mg. on the succeeding days. By the fourth day the dicumarol may take over for the heparin. Its effectiveness should be checked with daily prothrombin time determinations. The prothrombin time should not be prolonged to the point where spontaneous hemorrhages are likely to occur.

Sympathetic nerve block may be done just before the patient leaves the table. It should be repeated daily. Papaverine should be continued.

Intermittent Venous Compression.—Intermittent venous compression may be obtained manually or by mechanical means. In whatever way it is applied, the aim of the therapy is to restrict the venous return from an extremity without obstructing arterial inflow. This will allow an accumulation of blood which will fill the vascular network of the extremity. This is secured by applying a blood pressure cuff and inflating the cuff to a reading of from 50 to 70 mm. of mercury and maintaining that pressure long enough to fill the cutaneous veins. If no veins are visible, the development of a cutaneous flush may be used as indicating a satisfactory filling of the smaller vessels. The pressure may be left off long enough to allow emptying of the vessels. In each case the method and use of intermittent venous compression must be modified. There are mechanical devices which will apply the pressure as long as desired and at as high a pressure as wished.

When the patient is back in bed, intermittent venous compression should be instituted and it should be used continuously. We regard this treatment to be of great importance. In a patient (Case 1) whose sclerotic artery was opened for embolectomy twenty-seven hours after occlusion it was used continuously. He received no heparin, and his leg returned to normal. In another patient (Case 5) the intermittent venous compression was done by hand. The satisfactory appearance of the patient's limb lasted for seven days, with no heparin. At that time treatment was discontinued and by the tenth day the leg was gangrenous.

We have reserved the use of refrigeration for those extremities which were unquestionably beyond therapy, because we feared the possible

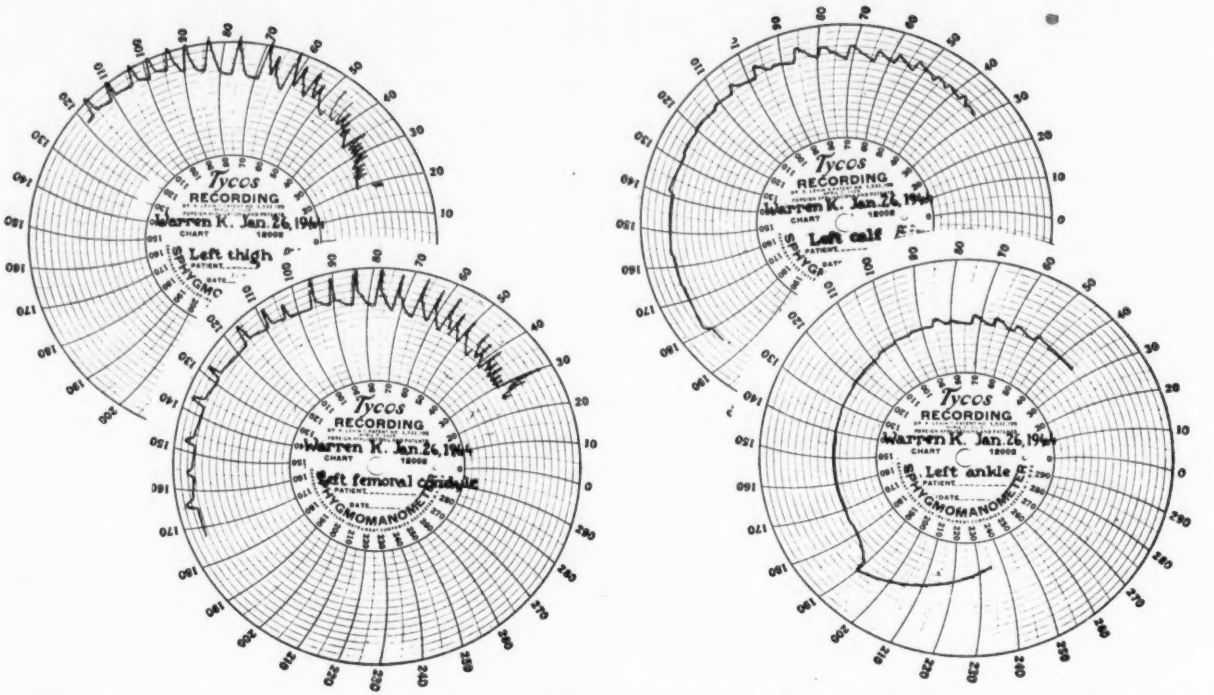

Fig. 11 (Case 2).—Oscillometric tracing taken fifteen months after embolic occlusion of the popliteal artery. Note the definite pulsation in the calf and ankle tracings. These pulses were not present in the immediate period following the lodging of the embolus while the collaterals were taking over.

development of an "immersion limb" as a result of this treatment. Its recent effect on two patients (Cases 12 and 13) has been so encouraging that in the future its use may well be extended.

Complications.—Four patients in this series developed significant phlebitis. The first patient (Case 7), who was convalescing after successful removal of an axillary embolus, developed a phlebitis of the left femoral vein which gave rise to a fatal pulmonary embolus. The second patient (Case 15), who was not operated upon for a popliteal embolus, developed a phlebitis three days after the localization of the arterial embolus. A ligation of the superficial femoral vein was done. The third (Case 12) required amputation for gangrene following embolic occlusion of the iliac artery. The common femoral vein was so occluded by thrombosis that a prophylactic ligation was impossible. A fourth patient (Case 5) developed a small pulmonary infarct on the day her leg was amputated but recovered satisfactorily. Prophylactic ligation was not done.

Duration of Treatment.—The treatment may be discontinued after a week or ten days when it is apparent that the peripheral pulse has been restored. When this has not occurred or when operation has not been undertaken, the cessation of treatment should be done gradually. The sympathetic block may be dispensed with after a week. Intermittent venous compression may then be given less intensively. The anticoagulant should be continued the longest. Two or three weeks should be a minimum time.

Analysis of Results.—The tables presenting our results in the treatment of twenty-four patients with embolic occlusion of major arteries are self-explanatory.

DISCUSSION

Antispasmotics.—In major occlusions of the lower extremities, Atlas and others[20, 28] have recommended observation of the effect of antispasmotic therapy in the form of papaverine and/or sympathetic block before operation. This recommendation is based upon the possibility that a minor embolus may initiate mass reflex arteriospastic phenomena and that the femoral arteries possibly closed by such spasm may resume pulsation under the influence of the antispasmotics. However, we have not seen such an occurrence. We believe that little harm can be done in exposing a nonpulsating contracted empty femoral artery, whereas the danger of passage of an embolus into the relatively inaccessible periphery is excessive and has occurred in our experience (Cases 9 and 13). In addition, delay adds to the likelihood of thrombosis in the artery peripheral as well as central to the embolus. We agree with those[6, 21, 22] who feel that conservative treatment is to be used only until the patient can be taken to the operating room. Roome's report of failure with sympathetic block emphasizes that it should be used only as an adjunct to other forms of therapy.

TABLE I

RESULTS TO CIRCULATION IN LIMBS SUBJECTED TO EMBOLECTOMIES

CASE	RESULT
4, 5, 6, 10, 16*, 18, 19, 20	Circulation restored—patients died of cardiac disease in less than six days after removal of embolus
1, 2†, 7, 24	Circulation restored permanently but patients died later
13	Embolus not obtained
9	Embolus moved
11	Result uncertain

*Two separate emboli removed from different arteries during the same operation.

†Three separate emboli removed at different times—one eight months, one four months, and one six days before death.

The case against the use of antispasmotics has been aptly expressed by Griffiths who says ". . . if an embolus could be made to move from a critical position, there is no way of guaranteeing that it will move into a safer one." Pratt quotes Lund, McKettrick, and Allen as believing that the arteriospasm prevents the formation of a tail thrombus. However, this opinion is not supported in our experience because in one patient (Case 6) a long tail thrombus was found.

TABLE II

RELATIONSHIP OF THE TIME INTERVAL BETWEEN DEVELOPMENT OF EMBOLUS AND ITS REMOVAL

(EIGHTEEN ATTEMPTED EMBOLECTOMIES CARRIED OUT ON FIFTEEN PATIENTS; FIFTEEN SUCCESSFUL EMBOLECTOMIES OBTAINED IN THIRTEEN PATIENTS)

CASE	TIME INTERVAL (HR.)	RESULT TO LIMB
20	2	Good
18	3	Good
16	4	Good
16	4	Good
2	5	Good
19	5½	Good
2	6	Good
6	6	Good
7	8	Good
5	9	Good (with help)*
4	10	Good
24	18	Good
11	20	Uncertain
10	23	Failure
1	27	Good

*It will be seen that of the fifteen limbs subjected to embolectomy, ten were operated upon before eight hours; all had satisfactory results. After eight hours the results were variable, but one man (Case 1) recovered when the embolectomy was performed twenty-seven hours after the occlusion.

TABLE III

RELATIONSHIP OF LOCATION OF EMBOLUS TO RESULTS OF THERAPY

LOCATION	NUMBER OF CASES	RESULTS
Aortic	4	All shifted to lower location
Iliac	8	7 operated upon: 4, immediate restoration of circulation; all died of cardiac disease 1, permanent cure (died of recurrent embolus eight months later) 1, failed to obtain embolus; amputation 1, questionable result; died before circulation definite 1 not subjected to operation; amputation
Femoral	12	10 operated upon: 5, temporary good results 3, permanent good results 2, failures (embolus moved; no restoration of circulation) 2 not operated upon; amputations; 1 died
Popliteal	6	6 not operated upon: 2, amputations 4, recovered
Axillary	2	1 operated upon; recovered 1 not operated upon; recovered

TABLE IV

RELATIONSHIP OF CARDIAC DISEASE TO EMBOLI AND OUTCOME

NATURE OF CARDIAC LESION	NUMBER OF EMBOLI	DEATHS
Arteriosclerotic (hypertension)	12	4
Rheumatic	5	3
Coronary	2	1
Thyrotoxic myocardial degeneration	1	1
Aortic plaque	1	1
Syphilitic	1	1
Undetermined	2	2

TABLE V

RESULTS IN PATIENTS WHOSE LIMBS WERE NOT SUBJECTED TO EMBOLECTOMY

CASE	LOCATION OF EMBOLUS	RESULT
3	Popliteal	Recovered
8	Femoral	Amputation
12	Iliac	Amputation
14	Popliteal	Amputation
15	Popliteal	Recovered
17	Popliteal	Recovered
21	Popliteal	Recovered
23	Popliteal	Amputation
22	Axillary	Recovered

NOTE.—Although none of the patients who were not operated upon died, it is seen that most of these occlusions occurred in the more peripheral arteries.

TABLE VI

ANALYSIS OF CAUSE OF DEATH

CAUSE OF DEATH	CASE	TOTAL
Cardiac (presumed)	4, 6, 11, 16, 18, 20	6
Cardiac (certain)	19, 24	2
Multiple emboli	2	1
Pneumonia	1	1
Pulmonary embolus	7	1
Infected stump	5	1
Cholecystitis	9	1
		13

Anticoagulants.—We believe that too little emphasis has been laid upon preoperative use of heparin and we feel that this drug should be given immediately after the diagnosis of embolic occlusion is made. This is important irrespective of the operative removal of the clot, since under all circumstances it is imperative that the fluidity of the peripheral blood be maintained. This view is supported by the successful cases reported in the Scandinavian literature[3, 9, 10, 12, 25] as well as those of Murray. Nine of Murray's seventeen patients operated on were able to leave the hospital with the circulation restored.*

Intermittent Venous Compression.—Linton has been a great advocate of the use of intermittent venous compression. He has reported aortic occlusion in a patient who was successfully treated with intermittent venous compression. Its invaluable aid in the maintenance of circulation in some of our patients has been mentioned.

Danger of Gangrene.—The occasional practice of permitting gangrene to develop followed by amputation of the gangrenous part is strongly to be deprecated. In occlusions of the aorta, failure to restore the circulation has invariably resulted in death.[6, 8, 23, 24, 27] It can be seen from Danzis' collected figures that the greater the gangrenous areas (which are of course proportional to the size of the occluded artery), the greater the mortality. Thus in eighteen patients with iliac emboli, all five who survived had the circulation restored; and of the thirteen who died, the circulation was restored in only one, partially in one, and not at all in nine. Circulation was not restored in seventeen of the twenty-eight patients with femoral emboli, nor in four of the six with popliteal emboli who died.

Determination of Need for Operation.—In our opinion, an operation should be resorted to only when the circulation is inadequate. We feel that the signs most useful in judging inadequacy of circulation are those emphasized by de Takats—significant prolongation of venous filling time and the inability of the patient to use freely the muscles of the area whose blood supply has been threatened. Failure to report these observations in some of the cases described in the literature leaves open the question as to whether embolectomy was indicated.

*It may be significant that heparin was not used in many of the reported cases in which embolectomy was a failure.[4, 5, 7, 18, 24, 27]

This is emphasized because removal of an embolus from an extremity whose circulation is only partially obstructed is much more likely to be followed by a satisfactory recovery than removal of an embolus from a limb which has been totally deprived of its main arterial supply. These facts are particularly important in judging the indications for and the results of operative removal of emboli from the popliteal artery and from the vessels supplying the upper extremity. In all of our patients with popliteal emboli there was evidence of adequate collateral circulation from the start; none were subjected to embolectomy and the patients who later required amputation were those who did not receive proper care (anticoagulants, intermittent venous compression, and antispasmotics).

Results of Embolectomy.—We must consider the effective restoration of the circulation as the criterion of successful surgical care in spite of the high final death rate which is to be expected in these cases. Optimum return of circulation implies restoration of pulses (which occurred in two extremities reported here). Actually it is satisfactory when gangrene does not occur, when the patient can move the digits freely, and when the extremity is free of pain. Thus in our series there were sixteen limbs operated upon from which emboli were successfully removed. Of these, thirteen, or 81.25 per cent, had restoration of circulation which was thought clinically to be satisfactory. These figures alone tend to make Neuhoff's pessimism unwarranted. These figures compare favorably with those of others. Thus one arm was usable for the month the patient survived; one leg was used for eight months, one for four, a third for one month, and a fourth for two and one-half weeks. In these patients death from "cardiac" or other similar causes (pulmonary embolism, recurrent arterial embolus) intervened. The remaining patients who had satisfactory restoration of circulation died in less than six days postoperatively and five of them within forty-eight hours.

Early Mortality.—The relatively early death following the restoration of circulation in our patients has been a matter of great concern. Thus seven patients (Cases 4, 6, 11, 16, 18, 19, and 20) died within six days of the operation, and in all but one (Case 11) the circulation had been restored very satisfactorily. The death in these patients was not sudden, and although considered to be "cardiac," there was no positive evidence to support such a diagnosis. This observation is not a common one as judged by the recorded cases, although two of Murray's patients with aortic occlusion, two of Danzis' and one of Key's died soon after operative restoration of the circulation. In Danzis' report, no patient with iliac occlusion died within the first week with satisfactory restoration of circulation. Of those with femoral occlusion, thirteen died in the first three days following embolectomy, but it is difficult to judge which of these had a satisfactory circulation. In McClure and Harkin's

series, only two patients (Cases 5 and 9) died in the immediate postoperative period and in neither was the circulation considered to be adequate. We do not know the significance of this observation.

General Mortality.—Although our mortality is high, the mortality is high in other reported series. We do not often see the patients with arm and popliteal emboli because of our known belief that most of these do not require surgical intervention. By excluding this kind of case, our series includes a larger proportion of embolic occlusion of the larger arteries of the lower extremity. This may contribute some to the relatively high mortality in our series.

McClure and Harkins report ten cases, nine involving the lower extremity; one each of popliteal, femoral, and iliac occlusion were treated successfully; two patients of this group died within a year of other emboli. Four successful cases were reported by Lesser without mention of other cases seen or operated upon. Linton reported two successful cases, one of an axillary embolism; two others in which amputation was required, and one successful aortic case treated with intermittent venous compression. He does not state what proportion of his total experience with emboli these reported cases represent. Dickson reported six operations for embolectomy (performed upon five patients). Five of the six limbs required amputation, and one patient recovered. Heparin, intermittent venous compression, and antispasmotics were not employed as a part of the therapy. No mention was made of patients not subjected to operation. In Pearse's six cases published in 1933 heparin was not administered, and intermittent venous compression was not used. Two patients with femoral and popliteal emboli, respectively, required amputation; one with aortic and one with brachial occlusion died, and one with brachial, one with femoral, and one with posterior tibial occlusion were successfully treated. These patients were able to leave the hospital with useful extremities. In Lund's large series of cases an improvement in the rate of survival of limbs was seen on comparing the more recent to the older cases and anticoagulants were not used.

In only two of our own patients (Cases 19 and 24) was the death definitely cardiac, that is, sudden and without warning.

SUMMARY

Heparin should be administered as soon as the diagnosis of arterial embolus is made. This is done in order to prevent a thrombosis of the blood distal or central to the embolus, which, should it occur, would make all attempts to restore blood flow futile.

Sympathetic block should not be used in aortic, iliac, or femoral embolic occlusion until the operation has been done, because the resultant vasodilatation may allow the clot to progress and escape into vessels from which it can no longer be removed with ease.

Embolectomy should be done as soon as possible after diagnosis.

Most occlusions of the femoral and iliac arteries and the aorta may be satisfactorily displaced by approach through an incision in the femoral artery.

Emboli in popliteal and axillary vessels require removal only when the use of muscles supplied by the vessels remains impossible.

Heparin, intermittent venous compression, antispasmotics, and/or sympathetic blocks should be used as forms of treatment accessory to embolectomy. They should also be used when no embolectomy is done. Their use must be continued for some time.

Attention must be constantly directed to the cardiac disease which in itself may be fatal.

Twenty-four patients with twenty-seven limbs rendered ischemic by embolic occlusion have been studied. Of these limbs, nine were not operated upon. Eighteen limbs were operated upon. In one patient the embolus had moved, and in a second the embolus could not be obtained. Thus there were sixteen limbs from which an embolus was removed at operation from thirteen patients.

Ten of these emboli were removed within eight hours of their occurrence; all of the patients had satisfactory return of the circulation. Of the remaining six patients, four were successfully treated (one after twenty-seven hours), one result was doubtful and one was a failure.

Twelve of the patients studied died. All of these had had emboli removed. Seven patients died within the first few days after the removal of the embolus, apparently from cardiac failure, and all had had successful restoration of the peripheral circulation. Deaths in four of the remaining five were from causes not related to the heart disease or the embolus and might therefore have been avoided.

CASE REPORTS

CASE 1 (Cook County Hospital).—A. H., a psychotic 60-year-old white male, was suffering from myocardial decompensation at the time he developed an embolic occlusion of the left femoral artery. Although not subjected to embolectomy until twenty-seven hours after the occurrence of the occlusion, and although the artery in which the embolus had lodged was the site of extreme arteriosclerosis, the circulation of the leg recovered sufficiently to allow it to be useful. Heparin was not used, but intermittent venous compression was applied constantly for two weeks. Five weeks after the embolus was removed, and three weeks after all local treatment to his leg was stopped, the patient died from bronchopneumonia.

Comment.—At the time of operation no pulse was restored in the periphery of the leg. Intermittent venous compression was used constantly, and it was the impression of all who watched the leg that this treatment was responsible for the recovery of the circulation. Heparin was not used.

CASE 2.—M. M., a 53-year-old schoolteacher, entered St. Luke's Hospital Dec. 12, 1941. Three hours previously she had developed pain in both lower extremities and was unable to move either of them. Her previous history mentioned an episode of rheumatic fever in childhood and she had had transient attacks of decompensation which had been treated with digitalis and rest. From December 1 to 4 the patient

took 3 gr. of digitalis daily because of extreme fatigue. On December 4 she developed severe abdominal pain which was treated with morphine; this was followed by numbness and paresthesia in both lower extremities and a transient attack of blindness. On December 7 these symptoms were followed by an embolus in the left femoral artery. When she entered the hospital auricular fibrillation was present. The left leg and foot were immobile, cold, and pulseless. On the right, although no pulse could be felt in the foot, the femoral pulse was easily palpable.

Removal of the embolus from the left iliac artery was done six hours after the onset of symptoms. Retroperitoneal massage was required to obtain the large, soft, red thrombus. Administration of heparin was started four hours postoperatively. Digitalis was discontinued. Postoperatively the femoral and popliteal pulses returned. Those of the foot did not. The circulation of the leg was well restored when the patient left the hospital two weeks after the operation.

Approximately four months later the patient entered the hospital with the same symptoms in the right leg. A similar operation was done on the right leg, four hours after the onset of symptoms. The embolus was found at the level of the origin of the profunda femoris artery. There were pulsations in the dorsalis pedis artery when the patient returned to her bed. Heparin was again used postoperatively as was intermittent venous compression. She was dismissed sixteen days after embolectomy.

A third admission was made July 24, 1942, three months later. A saddle embolus of the aorta was diagnosed three hours after the onset of symptoms. These were not relieved by papaverine. On entrance both femoral arteries were pulseless and both extremities were cold and mottled below the middle of the thigh. Paravertebral block greatly improved the right but not the left side. Left femoral embolectomy was done six hours after onset of symptoms. The embolus was located at and above the previous suture line in the artery. Proximal blood flow was completely restored, but distal flow was poor. Gradual discoloration and intractable pain developed in the left foot and lower leg. On Aug. 6, 1942, an amputation was done below the knee. Some of the muscle looked necrotic. On August 15, nine days after amputation, an embolus occurred in the right femoral artery. The right leg became frankly gangrenous to the upper third of the leg. This right femoral embolus also shut off the remaining circulation to the left leg, and the stump now became gangrenous. Because of elevation of temperature, both legs were packed in ice and an amputation through both thighs was done under refrigeration anesthesia Aug. 27, 1942. The following day the patient developed hyperthermia, convulsions, and loss of consciousness and died. Autopsy confirmed the diagnosis of mitral heart disease and embolus to the bifurcation of the aorta and to the cerebral vessels.

Comment.—This patient had had a change of digitalis dosage preceding the development of her first embolic phenomenon. She recovered from two major embolectomies but succumbed when a barrage of emboli progressively blocked her peripheral arteries. The phenomenon of the second embolus on the right, shutting off the remaining source of collateral to both legs, is of interest. The two successful embolectomies were both done within the first six hours of occurrence.

CASE 3 (No. 53795, Cook County Hospital, 1942).—W. K., a white male 30 years of age, suffered from symptoms of cardiac decompensation for two months previous to entrance to the hospital. A cough with occasional blood-tinged sputum was concomitant with anorexia and nausea. At the same time, three weeks prior to entrance to the hospital, he noticed the smoky red color of the urine. At 5 P.M., Oct. 21, 1942, he developed a sudden attack of pain in the left leg. The patient entered the hospital at midnight. At that time he was very ill. Auricular fibrillation was present, pulse was 144, and there were many skipped beats. He was severely decompensated at the time, his liver was palpable below the costal margin, and there were râles audible in both pulmonary bases. The left leg below the knee was cold, white, and

pulseless, but he could still move his toes. Recording oscillometric tracings (Fig. 9) taken at that time show the increased oscillations just above the occlusion and the sudden interruptions of the pulsation at the site of the occlusion. The man was too ill for embolectomy and did not need it since his calf muscles could still be used. The one sympathetic block which was done upset him so that no more were attempted. His leg recovered slowly, the color gradually returned, and he is able to walk on his leg at the present. Although there has been muscle atrophy, he has a very slight foot drop and there is a palpable pulsation in the dorsalis pedis artery which is seen in Fig. 11.

Comment.—This patient with rheumatic heart disease was so severely ill that the effort of undergoing lumbar sympathetic block was more than he could tolerate. The usefulness of his calf musculature indicated that a satisfactory outcome might be anticipated. Of particular interest is the return of pulsation in the dorsalis pedis artery after it had been pulseless for days. The use of heparin here might have resulted in a stronger arterial pulse and might have helped assure the patency of the popliteal artery above the embolus.

CASE 4 (No. 41253, St. Luke's Hospital).—G. F., a 42-year-old white female and a known cardiac patient had been taking digitalis irregularly. She had developed symptoms of a saddle embolus at the aortic bifurcation at 4 P.M., but by 7 P.M. the pain had left the right leg which at the same time became warm and pink. When she entered the hospital at 9 P.M. there was no pulse in the left femoral artery. Papaverine and paravertebral block did not relieve the symptoms, and at 2 A.M., March 6, 1943, under general anesthesia, the left iliac artery was exposed through an incision just above the inguinal ligament. The iliac artery was opened and a small embolus removed, and because the clot could not be extracted through this incision, another was made higher in the artery. Through this one the entire massive embolus was extracted. Free massive flow of blood followed. The iliac vein was ligated because the iliac vessel distal to the two incisions was not pulsating vigorously.

The patient was given heparin postoperatively as well as intermittent venous compression and papaverine. Her leg seemed slightly warmer and was pink when the compression was in its positive phase. The leg was painful, however. During the forty-eight hours after the operation her pulse and respiratory rate were elevated and she died from what seemed to be cardiac failure. The clinical impression was that the circulation of her leg had recovered sufficiently to allow it to survive. There were no pulsations in the foot.

Comment.—The treatment of this patient might have been improved. First, she should have had heparin preoperatively, but since there was no tail clot seen, this may not have been essential in her case. The iliac might best have been cleared from the femoral artery (see Cases 16, 19, and 20). This would have avoided a general anesthetic.

CASE 5 (No. 12336, Cook County Hospital, 1943).—G. P., a 41-year-old Negro housewife, entered the hospital March 13, 1943, for care of an acute coronary artery occlusion which had developed three days before entrance. While under care the presence of a mild diabetes mellitus was discovered. She was treated for both complaints and did well until April 23, when she developed a sudden pain in the left leg. It could not be moved, and examination revealed pulsation in the femoral artery only as low as a point 5 Cm. distal to the inguinal ligament. A fairly large embolus was removed from the femoral artery nine hours after its occurrence. The embolus had entered the profunda, and this portion of the embolus had to be pulled out to secure retrograde bleeding from the profunda branch. The femoral vein was ligated. No heparin was given postoperatively, but intermittent venous compression was maintained manually by patients on the ward. At the end of a week the leg was warm and had little pain but the foot was cold. The compression at this point was dis-

continued. The leg immediately began to develop blebs and was soon unquestionably lost. An amputation of the thigh became necessary May 12. The stump became infected and the patient succumbed to the infection May 31.

Comment.—This patient died from infection of an amputation stump. The amputation might have been avoided if heparin had been available and if an automatic intermittent venous compression could have been maintained for a longer period of time. The sudden change in the condition of the leg following the discontinuance of the intermittent venous compression was striking. Her cardiac condition was not a serious problem in the postoperative course.

CASE 6.—F. H., a 75-year-old housewife, had been treated for her cardiac symptoms for about a year. In the period immediately preceding the onset of her embolic phenomenon her digitalis dosage had been increased by 3 gr. daily. On April 11, 1943, at about 3 P.M. she developed agonizing pain in the left leg. She was brought to St. Mary's Hospital in Streator, Ill., by her physician, April 12, and at that time gave the history that at 6 A.M. she had developed similar pain in the right leg. The left leg at that time was severely discolored halfway to the knee, but the right leg was merely of marble whiteness (Fig. 5). The right leg was operated upon at 10 A.M. and an embolus was removed from the femoral artery at a point about 6 cm. distal to the inguinal ligament four hours after it had lodged there. Attached to this embolus was a tail thrombus twenty-six inches long (Fig. 2). The condition of the leg immediately after operation was very satisfactory, and although there were no palpable pulses, the leg was warm and the pain gone. Intermittent venous compression was applied to both limbs. The patient's cardiac condition, grave since the onset of the embolic phenomena, increased in severity and she died thirty-six hours after the operation.

Comment.—In this instance the successful early removal of the arterial obstruction resulted in satisfactory circulation to the involved extremity. The patient succumbed in the immediate postoperative period to her cardiac disease. The relationship of the digitalis therapy to the development of the emboli in this case is not precise since the exact date of change of digitalis therapy is not known.

CASE 7 (No. 21705, Cook County Hospital).—E. J., a white male 46 years of age, entered the hospital for care of a bleeding gastric ulcer May 5, 1943. On the sixth day of hospital stay he developed a cold, painful arm. The forearm was useless. Although no source for an embolus could be predicated from his complaints or examination, such a diagnosis was made of necessity. A clot one and one-half inches long was removed from the distal portion of the axillary artery, and the clot extended down into the circumflex humoral artery. Embolectomy was done less than twelve hours after onset of symptoms. The arterial pulsation did not return in the arm, but there was immediate improvement in the color of the hand, which could now be used. Intermittent venous compression was started. A stellate ganglion block was done at the conclusion of the operation and was repeated daily. Too much compression led to a slight edema of the hand which was corrected when the pressure was readjusted. The patient's hand was out of danger within a week after the embolectomy. He continued to bleed from his gastric lesion, for which transfusions were given. He developed recurrent attacks of thoracic pain which were finally recognized as due to pulmonary infarcts arising from an obscure thrombosis of the deep calf veins of the left leg. Frank femoral thrombosis finally developed and a massive fatal pulmonary embolus occurred June 16, 1943. His arm was in good condition at that time. Autopsy reported the following findings: Acute empyema of the left pleura after subacute embolus in the main branch of the pulmonary artery of the left lower lobe, following old thrombosis of the left femoral vein; multiple recent anemic infarcts of the right lower lobe after emboli; compression atelectasis of the left lung; compensatory emphysema of the right lung; moderate sclerosis of the ascending aorta with a shallow ulcer at the crest of the

arch and a large mural thrombus; scar in the left axilla after removal of thrombus in the brachial artery; severe parenchymatous degeneration of the myocardium with moderate coronary sclerosis; progressive circular carcinoma of the pylorus with acute marginal bleeding ulcers; progressive nephrosclerosis; chronic ulcerative proctitis.

Comment.—This patient developed the arterial embolus from the mural thrombus of the arch of the aorta. Although the upper extremity is rarely seriously endangered by emboli lodged in the arteries, this was thought to be an operative case because the obstruction was sufficient to render the forearm useless. The pulmonary embolus might have been prevented by prophylactic femoral vein ligation. The carcinoma of the stomach was resectable. Aside from the mural ulceration of the arch of the aorta, his serious maladies were amenable to therapy.

CASE 8 (No. 32807, Cook County Hospital, 1943).—F. S., a white male 40 years of age, was being treated for coronary artery occlusion. At 2 P.M, July 23, 1943, eleven days after coronary artery occlusion, he developed a pain in the left leg as high as the knee. The left leg was mottled, cold, and pulseless, and the patient was unable to move the toes voluntarily. Nitroglycerine was given at that time. The patient was seen at 11 A.M. the next day, twenty-one hours after the occlusion. The cessation of arterial pulsation in the left femoral artery was palpable just 3 cm. distal to the inguinal ligament. The leg was cold and pulseless, and the patient could not move the toes voluntarily. While being examined there was a sudden change of the color of the leg. It seemed to develop some circulation and the distinct line which seemed to separate the mottled area of the leg from the normal area became less sharply demarcated. Thinking that this indicated either a shift of position of the embolus or the widening of significant numbers of collateral vessels, it was noted that the venous filling time was but little prolonged. Nonoperative treatment was decided upon. Heparin was administered, intermittent venous compression instituted, and paravertebral sympathetic blocks were given daily. By July 30 there was definite mottling over the entire calf but no blisters were visible. At that time it was not thought that the leg was unquestionably lost. By August 3 blebs had formed and on August 8 the leg was amputated because of severe pain. The patient is alive and walking on crutches today.

Comment.—This patient developed a peripheral embolus eleven days after his myocardial infarction. His case is of particular interest because of the apparent spontaneous improvement in the circulation which occurred twenty-one hours after the embolus developed. This change in circulation was not sufficient to maintain the viability of the leg, which subsequently required amputation. However, in this instance the leg was not unquestionably lost for over a week, and it was the feeling of physicians who watched the patient's progress that the heparin, intermittent venous compression, and paravertebral sympathetic blocks would have been successful had an embolectomy been done, even as late as twenty-one hours when the change in circulation took place.

CASE 9 (No. 40404, 1943).—E. W., an elderly Negro female, entered the hospital Aug. 31, 1943. Her condition was diagnosed as an acute cholecystitis with perforation and possible subdiaphragmatic abscess. On the twenty-fifth day of her stay she developed a sudden attack of pain in the left foot. The leg was cold and pulseless and she was unable to move the toes two hours after the onset. Twenty-two hours after the onset a definite and abrupt cessation of palpable pulsations in the femoral artery was palpable 3 cm. distal to the inguinal ligament. She had been given papaverine and one lumbar sympathetic block. An embolectomy was advised and a spinal anesthetic instituted. When the patient's thigh was palpated, the spot of arrest of femoral pulsations was no longer palpable. An incision was made over the femoral artery which was found to be patent and pulsating. It seemed that the spinal anesthetic had allowed the embolus to pass farther down the artery. No

oscillometer was available at the time. The leg progressed to develop gangrene. This served to exclude a diagnosis of arterial spasm. The condition of the patient became progressively worse and she died Oct. 9, 1943, thirty-nine days after entry and thirteen days after the embolic episode.

Comment.—The important observation in this patient is the shift of position of the embolus which occurred after the spinal block. That it was not simply an arterial spasm is proved by the development of gangrene in the leg. The gall bladder condition was amenable to therapy and had the embolus been easily recovered from the femoral artery, the patient's clinical course might have been improved.

CASE 10 (No. 44128, Cook County Hospital, 1943).—A. S., a 49-year-old white woman, had known of her hypertension for five years. She entered the hospital Sept. 27, 1943, stating that at 1 P.M. she had developed numbness and pain in the right toes and leg. A transient attack in the left hand had occurred three days previously. When she was examined she was seen to be acutely ill, the blood pressure was 160/110, her pulse rate was 140, and she was cyanotic. The right leg was pale, cold, and useless. The point of arrest of the pulsations in the femoral artery was easily palpated 3 cm. below the inguinal ligament. The embolus was presumed to arise from the heart, diseased from her hypertension. At 10:30 A.M., September 28, a femoral embolectomy was done, twenty-one and one-half hours after the development of the embolus. There was marked adherence of the embolus to the surrounding arterial wall. Satisfactory circulation to the periphery was not re-established. The posterior tibial artery was exposed and an attempt was made to pass a ureteral catheter up the posterior tibial artery, but it was impossible to obtain through-and-through circulation of saline solution in this way. The femoral vein was tied.

The leg continued to discolor and an amputation was done October 11. A subsequent electrocardiogram was read as follows: Advanced left ventricular preponderance with rather marked ischemia of the anterior coronary branch but no evidence of coronary occlusion or infarction.

Comment.—The obvious difficulty here was the late operation and the lack of heparin in the pre- and postoperative treatment. The attempt to obtain retrograde clearance of the arterial network by forceful irrigation of the posterior tibial artery was unsuccessful. It might have been useful if the peripheral thrombosis had not progressed so far.

CASE 11 (No. 53428, Cook County Hospital, 1943).—L. L., a very obese 73-year-old white female, entered the hospital Dec. 2, 1943, suffering from myocardial decompensation with auricular fibrillation, best explained as due to cardiac hypertrophy concomitant to hypertension. She was treated with digitalis, 3 gr. being given daily. She improved surprisingly, so that by December 7 the pulse was 64. By the morning of December 8 she noted pain in the left leg, the onset of which was indefinite, because the patient was somewhat disoriented and did not answer questions accurately. The leg was cold and totally pulseless and she could not move it. A diagnosis of iliac embolus was made and an embolectomy was decided upon. At 8 P.M. the embolus was removed from the iliac artery just above the inguinal ligament. The femoral vein was ligated. Postoperatively she did not do well, was very restless, and it was impossible to maintain either proper heparin therapy (although some was given) or intermittent venous compression. Her cardiac condition remained very poor and she died December 13, five days after removal of the embolus. It was uncertain at that time whether or not the leg would have survived.

Comment.—The long delay in therapy occasioned by the patient's cerebral condition was important here. The failure to give heparin preoperatively may have had a bearing on the condition of the leg. Whether or not her restlessness, which prevented intermittent venous compression, was sufficient to encourage the movement of blood in the extremity may be speculated.

CASE 12.—(St. Luke's Hospital).—M. G., a septagenarian woman, was brought to the hospital Jan. 11, 1944, because of a transient hemiplegia which had developed in the course of a cardiac disturbance. She had had hypertension for several years. When she entered the hospital, the diagnosis of auricular fibrillation complicating the cardiac changes of hypertension was made. This was corroborated by the electrocardiogram which pointed to a coronary artery disease which could have been the result of multiple myocardial infarctions. During her stay in the hospital she was irrational. On January 17 it was noted that there was marked discoloration below the lower third of the calf. The leg was warm as low as the knee, but there was no pulsation palpable in the femoral artery. Irreversible changes had already occurred in the leg. The leg was kept cold, during which time the cardiac condition improved, and January 25 a supracondylar amputation was done, using refrigeration as the means of anesthesia. The patient is still in the hospital, the cardiac and cerebral conditions requiring the hospital stay.

Comment.—The femoral artery was one of many arteries occluded when this patient developed a cardiac crisis. The cerebral embolus no doubt gave rise to the psychic changes which prevented the patient from complaining when the iliac artery was occluded. The rapidity with which the peripheral changes became irreversible may be explained as due to the circulatory inefficiency and may well have been prevented by early administration of heparin.

CASE 13 (No. 57121, Cook County Hospital, 1943).—M. M., a 34-year-old white female entered the hospital Dec. 28, 1943, suffering from severe auricular fibrillation. The basis of this was rheumatic heart disease. She had taken digitalis irregularly since she had developed myocardial decompensation two and one-half years before. A severe cold had preceded the present attack. When she was examined her pulse was 140 per minute and was very irregular, and there was evidence of decompensation in that there were râles in both pulmonary bases and in that the liver was palpable three inches below the costal margin. She was given 1½ gr. of digitalis four times daily. On December 30 her pulse was 100. On December 31 the digitalis was reduced to 1½ gr. twice each day. Fibrillation was still present. On Jan. 1, 1944, the dosage of digitalis was cut to 1½ gr. every morning. The lungs were clear. On January 4 there was great pain in the right renal region and a diagnosis of right renal infarct was made. On January 13 her pulse was 60 at the apex and 55 at the wrist. Digitalis was stopped. She was apparently ready to get up. At 4:40 P.M. she developed paresthesias of both legs. There were no pulsations in either leg. A diagnosis of saddle embolus at the aortic bifurcation was made. By 6:40 P.M. pulsations were found in the left femoral artery and it was presumed that the embolus had been washed into the right iliac vessels. At 8:30 P.M. 5 c.c. of heparin were given and at 9:25 P.M. operation was begun. We were unable to extract the embolus from where it had apparently lodged at the bifurcation of the iliac vessels. Spasm of the iliac artery was so great that at times it grasped the probe. We hoped that the spasm was the entire cause of the ischemic extremity. The gangrene which developed after the operation was evidence that there was a definite organic occlusion. The gangrene developed in spite of the use of heparin, paravertebral blocks, and ice bags applied to the leg. Since then the patient has had a major embolic occlusion of the left leg, which required amputation, and has had recurrent episodes of emboli to the upper extremities and to the cerebral circulation.

Comment.—The failure to remove the embolus in this patient was due to the reluctance to introduce the knobby instrument above the level of the occlusion and actively to extract the embolus which had no doubt been tightly wedged into the internal iliac artery. Experiences with three other patients (Cases 16, 19, and 20) in whom similar situations were encountered lead us to feel that such a difficulty would not remain unsolved in the future. The continued use of heparin was under-

taken to maintain the fluid state of the blood and to make use of every possible opportunity for adequate circulation to develop about the obstructed arterial segment. The use of the ice bag seemed to prolong the life of the limb and allowed a lower amputation than would have been possible otherwise.

CASE 14 (No. 1552, Cook County Hospital, 1944).—M. B., a 67-year-old Negro female, had a previous record in the hospital as a cardiac patient. She had had recurrent attacks of cardiac decompensation. Her last hospital stay had been in November, 1943. She entered the hospital Jan. 11, 1944, with similar complaints and findings; her pulse rate was 130 per minute and her blood pressure, 200/110. The diagnosis of myocardial decompensation was again made; she was given digifolin, 3 gr. three times the first day, and 1½ gr. twice daily thereafter. By January 15 her pulse was 78 and the digitalis was slowed to 1½ gr. every morning. On January 17 she had developed anorexia and a bigeminal pulse. This was interpreted as a sign of digitalis toxicity and the drug was discontinued. At 7:30 that evening she developed severe pain in the right leg. The leg was cold, but she could move the toes. There was neither dorsalis pedis or posterior tibial pulse. An occlusion of the popliteal artery was suspected, but since pulsations of the popliteal artery were palpable, the occlusion was presumed to be at its lowermost portion, where the bifurcation occurred. Paravertebral blocks were given daily, but on January 20 the foot was obviously discolored. At this time palpation of the popliteal fossa revealed that the pulsations which previously had been easily palpable had disappeared. An amputation was necessary on January 27.

Comment.—The development of thrombosis central to the position of occlusion in this patient is a point of great importance. It is probable that the use of heparin soon after the embolus has lodged would prevent thrombosis in patients with such an involvement as this who are not operated upon, as well as in those in whom operation is performed. This emphasizes the importance of anticoagulants in the treatment of embolic occlusion, whether or not operative removal of the embolus is undertaken. Intermittent venous compression might have been of help here.

CASE 15 (No. 3281, Cook County Hospital, 1944).—I. G., a 79-year-old white woman, entered the hospital for treatment of diarrhea. It was discovered that she was suffering from a rapid auricular fibrillation. The fundamental cardiac disease was presumed to be hypertension, even though her blood pressure on entrance was only 140/100. On January 28, six days after entrance, her fibrillation had disappeared. At 11 A.M. the patient developed pain in the left leg but said nothing about it. By 2:30 P.M. the dorsalis pedis was noted to be absent. At 3:50 P.M. she was unable to move her calf muscles. The venous filling time in that leg was one minute and twenty seconds as compared to twenty seconds in the good leg. The popliteal artery pulsated at least throughout two-thirds of its length. An embolectomy was decided upon. No heparin was available for preoperative treatment. On the way to the operating room she experienced a marked relief of pain in her leg and a sense of warmth returned. When examined, her leg was warm and there was no return of palpable pulse in the dorsalis pedis and popliteal arteries, but she could move the toes with ease. It was obvious that her circulation had been adequately restored. Her convalescence was uneventful. No operation was performed.

Comment.—A small embolus which blocked the bifurcation of the popliteal seriously apparently became fragmented and passed into the peripheral vessels. This allowed the establishment of enough collateral to render operative intervention unnecessary. Probably heparin should be given prophylactically to such a patient (see Case 14).

CASE 16 (No. 44587, Cook County Hospital, 1943).—E. D., a white woman 38 years of age, had known of her cardiac condition since childhood. This cardiac condition had given her considerable difficulty with each pregnancy. It had made her

heavy household duties particularly exhausting. In the period immediately preceding her entry into the hospital she had had a moderate amount of hemoptysis. She entered the hospital Jan. 31, 1944, with myocardial decompensation. She was given 3 gr. of digitalis on entrance and 1½ gr. every morning thereafter. On Feb. 6, 1944, at 1 P.M. the patient noted a sudden onset of tingling, followed by a sensation of cold in both lower extremities. After about ten minutes the legs became unbearably painful and she noted that she could not move either leg. At that time it was thought that she had developed a saddle embolus at the aortic bifurcation. A paravertebral block was done on both sides. After this the right femoral artery was palpable, pulsating to a point 4 cm. below the inguinal ligament, at which point it abruptly stopped. There was no palpable pulsation on the left side. The patient was given 5 c.c. of heparin and taken to the operating room at 5 P.M. Both femoral arteries were exposed in the inguinal region. The left femoral artery was opened first; it was empty, and an enormous folded clot (Fig. 1) was extracted from above where it apparently had lodged at the point of bifurcation of the iliac vessels. Free pulsation attested to the return of circulation, and the arterial incision was closed. The right femoral artery was opened at the site of occlusion, the point of femoral bifurcation, and the clot was removed (Fig. 1). The left femoral vein was ligated.

The patient's postoperative course was marked by a totally satisfactory circulation in both legs, which were warm, useful, and free of pain. The cardiac condition increased in gravity and she died thirty-two hours after operation in the picture of an acute cardiac failure.

Comment.—The early removal of the emboli from the occluded vessels in this patient was associated with the administration of heparin preoperatively. The successful result was followed by serious cardiac failure. Of particular interest was the precipitation of the cardiac attack by undue fatigue. In this patient the iliac embolus was extracted by making sure that the knobby end of the probe was above the embolus. The probe was then turned laterally and pulled down. This maneuver, not done in Case 13, might have been successful there. The heparinized blood did not coagulate in the operating room, but both arteriotomy wounds stopped bleeding without difficulty.

CASE 17 (No. 7634, Cook County Hospital, 1944).—J. M., a 60-year-old white male, was admitted to the hospital for care of myocardial decompensation. While being examined he experienced a sudden pain in the left leg. The pain was severe and constant, and numbness soon was noted. The toes were constantly useful. At that time the popliteal and femoral pulses were palpable, but neither dorsalis pedis nor posterior tibial pulse could be made out. A diagnosis of embolic occlusion of the bifurcation of the popliteal artery was made, but since the toes could be moved, it was felt that there was sufficient collateral to allow the patient to be treated without operative intervention. Papaverine was given and the patient recovered sufficiently to have good pulses in both posterior tibial and dorsalis pedis arteries.

Comment.—This patient was correctly treated without embolectomy because the usefulness of the calf muscles indicated adequate collateral. The return of good pulsation in the dorsalis pedis and the posterior tibial makes one feel that there may have been a good deal of arterial spasm involved in this clinical picture. It is difficult to conceive how an embolus large enough to have blocked the popliteal could so pass into a collateral large enough to hold it and still leave the anterior and posterior tibial vessels open. The patient did not develop cephalad thrombosis as did the one reported in Case 14. Heparin would have rendered such an occurrence unlikely.

CASE 18 (No. 8079, Cook County Hospital, 1944).—A. S., a 60-year-old white female, entered the hospital February 24. For eight months previously she had had complaints of dyspnea and swelling of her ankles; hemoptysis had occurred during the first seven days. A sense of oppression over the heart was present. On examina-

tion the pulse was 120, and the blood pressure was 190/40 in both arms. Her left pupil was larger than the right; both reacted to light and accommodation. A diagnosis was made of syphilitic disease of the central nervous system and of the heart. The latter had produced an aortic regurgitation and the patient was now suffering from myocardial decompensation. She was given 1½ gr. of digifolin, and by Feb. 29, 1944, she had received 24 gr. in four days. Her pulse had dropped from 120 to 88 per minute. A transient fibrillation had disappeared. At 5 P.M. the patient had a sudden attack of pain in the left leg, which became white, and she was unable to move the muscles of the calf. Palpation revealed a sudden cessation of femoral pulsation 5 cm. below the inguinal ligament. A diagnosis of embolic occlusion of the femoral artery at the level of bifurcation was made. Five cubic centimeters of heparin were given intravenously at 7:15 P.M. and she was given papaverine. Oxygen was given and three hours after the embolus lodged in the femoral artery, it was removed through an incision in the superficial femoral. The patient's vessels were noted to be as soft and pliable as those of a young adult. The patient's leg was warm and pink at the conclusion of the operation, and there was a very strong pulse in both the dorsalis pedis and in the posterior tibial arteries. All the pain disappeared from the leg before the patient left the operating room. The patient was maintained on heparin for six days and was given 300 mg. of dicumarol on the day of the operation and 200 mg. on the remaining days. Her leg remained in perfect condition, but her cardiac condition, after having improved during the first three postoperative days, became worse and she died on the sixth day.

Comment.—The total relief of the arterial obstruction in this patient resulted from the fortuitous combination of early administration of heparin plus early embolectomy. The unfortunate fatal outcome might have been anticipated since it is rare for a syphilitic cardiac lesion to give rise to emboli. There was, however, a definite period of auricular fibrillation noted.

CASE 19 (No. 8661, Cook County Hospital, 1944).—T. A., a 52-year-old white man, entered the hospital Feb. 28, 1944. At that time he was suffering from myocardial decompensation and diabetes mellitus. The cause of the cardiac decompensation was not known. He was given supportive treatment and digitalis, 3 gr. daily. On March 1, 1944, after having received only 9 gr. of digitalis, the patient developed an embolus to the left iliac vessels. The leg was cold, pulseless, white, and useless. Ten cubic centimeters of heparin were given intravenously four hours after the occurrence of the embolus, and the embolus was removed five and one-half hours after its occurrence, one and one-half hours after the heparin had been given. At the time of operation there was a tail thrombus three and one-half inches long extending into the femoral vessel (Fig. 4). The clot itself had to be forcefully pulled out of the iliac by engaging it with the scoop end of a lead bile duct probe. The flow of blood was violent as soon as the clot was removed. The femoral vein was not ligated. Postoperatively heparin therapy was continued, as was the papaverine. Dicumarol, 300 mg., was given. The patient's leg felt much better immediately postoperatively but there was no pulse. The next morning his leg and foot were warm and he could move his toes. At noon, just twenty-four hours after the removal of the femoral embolus, just after he had asked for dinner, he died suddenly.

Comment.—The death of the patient was obviously of cardiac origin. The leg had made a satisfactory recovery from its temporary occlusion. The rather massive tail thrombus which was present shows clearly the importance of administration of heparin. It is possible that if heparin had been given earlier, it might not have formed; that if the heparin had not been given, the entire arterial network would have been filled with clot.

CASE 20 (No. 7546, Cook County Hospital, 1944).—F. K., a 67-year-old white female, was being treated for hemiplegia which apparently had resulted from a cerebral arterial embolism. Auricular fibrillation and myocardial decompensation were

present and probably resulted from the changes in the myocardium resultant from long-standing hyperthyroidism. She developed a painful leg with resultant loss of movement Feb. 26, 1944, but this disappeared rapidly. On March 1, at 3 P.M. the intern had visited her and specifically noted that she could move her left toes. At 4:25 P.M. she complained of inability to move the left toes and of pain in the entire leg. At that time no pulse could be palpated in the left leg. Ten cubic centimeters of heparin were given at 5:30 P.M. and the femoral artery opened about two hours after the ambolus lodged. There was a moderately long tail thrombus found at the site of incision (Fig. 3), and a large clot was removed from the level of the bifurcation of the iliac vessels by the use of a long, lead ball stone probe. Bleeding was free. The heparin was continued postoperatively, and the patient's leg did well postoperatively; by the end of twenty-four hours she was able to use the muscles in the calf. She did poorly from the cardiac point of view and died forty-eight hours after the embolectomy from her cardiac condition.

Comment.—The careful observations of the house officer allowed a correct diagnosis of iliac embolism to be made in the face of a difficult clinical history. The early removal of the embolus associated with the use of heparin resulted in a successful restoration of circulation to the femoral vessels. In spite of the early diagnosis and the use of heparin, some tail thrombus had already formed. It is presumed that without heparin an even larger thrombus would have formed and rendered all attempts at restoration of circulation futile.

CASE 21 (No. 10234, Cook County Hospital, 1944).—P. O., a 63-year-old white male, was under treatment for cardiac decompensation and was progressing satisfactorily until the morning of March 10, 1944, when he found he could not stand on his right leg. The leg was cold and he was not able to move the toes of the foot as well as those of the left foot. He was able to move them, however. Because of the pain in the foot, the pulseless foot, the presumption was that the occlusion had occurred in the popliteal artery. The fact that he was able to use his toes made operative intervention seem unnecessary. Paravertebral blocks and papaverine resulted in a rapid return of warmth to the leg, and by the end of a week the leg was useful. Pulses did not return to the dorsalis pedis or posterior tibial arteries.

Comment.—This patient developed an embolic occlusion distal to the main portion of the popliteal artery. The maintenance of peripheral circulation resulted in the retention of ability to move the toes. Heparin would have added certainty to the favorable outcome.

CASE 22 (No. 12442, Cook County Hospital, 1944).—F. C., a 61-year-old white male, entered the hospital March 26, 1944, complaining of pain in the right arm and hand of a dull nature. He stated that his fingers felt numb and that he could move them with difficulty. He had been given 1½ gr. of digitalis because of ankle edema. His pulse was 70 and fibrillating; blood pressure, 190/90. He could move the fingers easily. Palpation of the axillary artery was easy, and the point of arrest of pulsation was readily felt at about the level of the insertion of the pectoralis major muscle into the humerus. The embolus could be palpated, distending the artery. No pulses were palpable in the periphery. A block of the stellate ganglion was done; he felt an improvement of the temperature of his fingers and he was able to move them better. This was continued daily and his arm recovered.

Comment.—This patient who developed an easily diagnosed embolism to the axillary artery had sufficient collateral to allow use of the musculature of the forearm. Hence embolectomy was unnecessary and he had progressed satisfactorily. Heparin would add assurance against cephalad thrombosis.

CASE 23.—Mrs. J., in her middle fifties, known to have hypertensive heart disease, complained of pain, numbness, and a sense of cold in her right leg below the knee. These symptoms had been present for twenty-four hours when she was first

seen by her physician March 22, 1944. At that time her pulse rate was 140 and irregular and there was some pulse deficit. Examination of the right leg revealed the palpable pulse in the popliteal fossa but none in the foot. Her foot was cold but she could move the toes. Diagnosis was made of hypertensive heart disease with auricular fibrillation and embolus to the right popliteal artery. Cardiac care was given in the home. When seen by one of us (J. T. R.) two weeks later her condition was much the same. Being influenced by the events which occurred in another of our patients (Case 14), anticoagulants were suggested at this time but were not obtainable. By the time two more weeks had passed by, her toes had all become gangrenous and there was a possibility that a portion of the foot would be lost. The cardiac condition had improved markedly.

Comment.—This case followed the course of events which occurred in Case 14. Anticoagulants and intermittent venous compression, as well as antispasmotics, might have maintained the viability of the leg long enough for adequate collateral to develop. It is probable that if they had been vigorously applied even at the end of two weeks the slowly developing gangrene might have been prevented.

CASE 24.—Mr. V. I., 72 years of age, was admitted to the Evanston Hospital at 12 M., April 17, 1944. He had been under care for cardiac disease for some time and on April 15 and 16 had had numerous unexplained episodes of transient circulatory and respiratory arrest, one of which lasted as long as ninety seconds. On the evening of April 16, sometime after 4, a vague sense of distress was present in the left leg. The leg felt cooler to the patient than the opposite leg, but at 8 the pulses in the foot were palpable. By morning only the upper two inches of femoral artery pulsated freely. In view of this femoral embolus developing several hours after the last episode mentioned above, the impression was that the previous episodes had been due to a ball valve thrombus in the left auricle which temporarily occluded the mitral orifice.

On entering the hospital there was a definite arrest of pulsation in the femoral artery at the level of the bifurcation, about 3 cm. below the inguinal ligament. Although the foot was not marble white, there was a definite line of demarcation in the middle of the calf below which the leg was mottled. There were no pulses in the foot, but the foot was pink; the superficial veins were not collapsed totally. The patient was able to move the toes of the foot very slightly. The clinical impression at the time was that an embolic occlusion of the superficial femoral artery had occurred but that in some way partial collateral circulation had been maintained in the rest of the leg. Five cubic centimeters of heparin had been given at 10:30 A.M. In spite of the limited circulatory efficiency, embolectomy was decided upon not only because of the patient's pain, but because of the danger of subsequent thrombosis peripheral and central to the embolus which would result in occlusion of the artery.

Under local anesthesia the femoral artery was exposed. The profunda femoris artery was seen to be almost again as large as the superficial femoral, and it was pulsating at the time. An embolus 2½ cm. long and about ¼ cm. in diameter was removed from the superficial femoral artery. The embolus had apparently gone well down into the superficial femoral, and the proximal end had only partially occluded the profunda. There was good retrograde bleeding from the superficial femoral before the embolus was removed and very heavy bleeding from above after the embolus had been extracted. The femoral vein was not ligated. After the closure of the arteriotomy there was excellent pulsation in all vessels palpable in the wound.

Pulses in the foot did not return postoperatively but the patient had less pain in the calf.

At the end of the week the patient was able to move the leg with comfort and, although no pulses had returned to the arteries of the foot, it was warm. Heparin and dicumarol had been used in addition to the intermittent venous compression.

Since there was no pallor of the extremity and since at the time of operation the distal superficial femoral seemed totally patent, no antispasmotics aside from papaverine were used.

The patient died suddenly during the night two and one-half weeks after the embolectomy. The preceding day he had had full use of his leg, and all therapy had been discontinued.

Comment.—The successful outcome of this patient's limb may be attributed to a combination of factors in addition to the underlying cardiac care. There was a fairly good collateral circulation during the time the embolus was lodged in the femoral artery, heparin was used preoperatively, the embolus was removed easily, and the postoperative care combined anticoagulants, intermittent venous compression, and antispasmotics.

It is of interest to point out that the patient had a temperature of over 102° F. postoperatively which required three days to disappear. This temperature may have represented absorption of toxic material which resulted from the inadequate blood supply to the periphery.

The authors wish to acknowledge the cooperation of the Attending Staff of the Cook County Hospital in allowing them the courtesy of seeing the patients in this series who were in the Cook County Hospital.

The authors wish to take this opportunity of expressing their gratitude to the House Staff at the Cook County Hospital for their help in controlling the heparin therapy.

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LIGATION OF THE AORTA AND BOTH COMMON ILIACS FOR ANEURYSM

Report of a Case and Review of Seven Operative Survivals of Aortic Ligation

Major David T. Monahan,* Medical Corps, A. U. S.

THE experimental work of Owings[1] on the gradual occlusion of the thoracic aorta has been referred to by Dr. Rudolph Matas as one of the greatest contributions to the surgery of the aorta. By means of rubber bands, Owings ligated the aorta of dogs in three stages, three weeks apart, and finally tied and severed the aorta; he was able in a small percentage of cases to have the animal survive in a normal state of health. His results encouraged me to apply the same principle of gradual occlusion in a case of aneurysm of the aorta in the human being, the results of which are a part of this report.

As pointed out by Bigger[2] and Elkin[3] in excellent reviews of the subject, from the time Sir Astley Cooper first ligated the abdominal aorta in 1817, till 1920, none of the twenty patients on whom this procedure was attempted survived to leave the hospital. Since 1920, twelve ligations have been attempted, and of these patients, seven left the hospital under their own power. On this basis these are termed successful cases by Bigger, and yet, survival for a matter of months is not convincing evidence of the value of surgery as a therapeutic agent. Some of these patients, a clinician might argue, would have survived as long or longer without interference. However, of these seven cases, in at least four the treatment has been of a distinctly curative nature and a less fatalistic attitude than that widely held by physicians would seem to be warranted by the results so far obtained. It is with the purpose of emphasizing these favorable results and pointing out that there is definite hope for surgical cure of aortic aneurysm that these seven cases are briefly reviewed and one personal case presented.

Case Report.—A Negro man, aged 49 years, was a munitions worker. He was first admitted to the Bridgeport Hospital in June, 1941, complaining of burning in the epigastrium after meals, bloating, belching, and low back pain. He had noticed a throbbing lump in the abdomen about a year previously. On physical examination, a lump the size of a pigeon's egg was noted just to the right of the umbilicus. There was a faint trace of occult blood in the stool and a gastrointestinal series showed a spastic duodenal cap. Hinton and Kahn tests were positive. It was felt at the time that the abdominal tumor was probably an aneurysm. The patient was discharged and advised to undergo antisyphilitic

*Assistant Surgeon, Bridgeport Hospital, on leave of absence.
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treatment. He was referred to me in February, 1942, with essentially the same complaints and a loss of twenty pounds in weight. He was again admitted to the hospital, and at this time physical examination showed a tall, slender man appearing to be in good general condition. Pupils reacted sluggishly to light. Heart and lungs were negative. Blood pressure was 128/80. Knee and ankle jerks were elicited with difficulty. Just to the right of, and slightly below, the umbilicus was a pulsating mass 2 by 2½ inches in size, not movable, over which a distinct bruit could be heard. It seemed to be directly under the abdominal wall. Temperature was 98.6° F.; red blood cells, 4,900,000; hemoglobin, 90 per cent; white blood cells, 5,400. Hinton and Kahn tests were positive. Nonprotein nitrogen, 34; urine, negative. He was seen in consultation by Dr. W. Lee Weadon, who agreed with the diagnosis of aortic aneurysm and felt that an exploration was indicated.

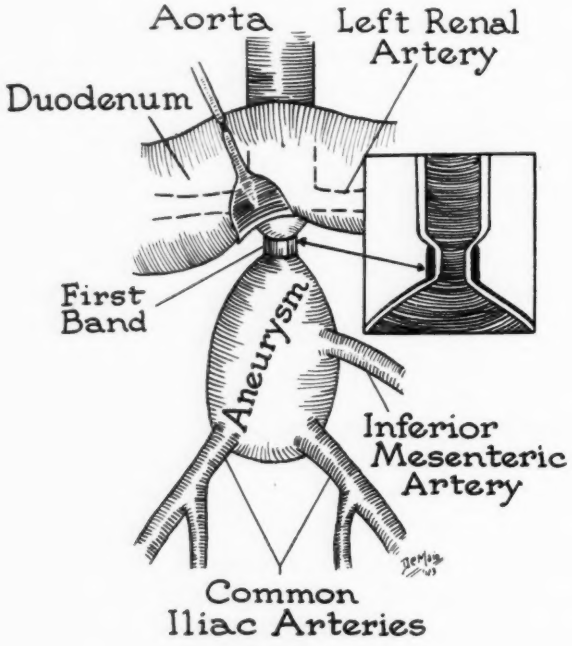


Fig. 1.—Band placed proximal to aneurysm and circulation cut off about 75 per cent.

Operation.—First Stage, March 20, 1942: Under 1½ mg. spinal pontocaine, a four-inch incision was made just to the right of the midline and the peritoneum opened. The pulsating mass was immediately identified and was found to involve the lower end of the aorta. It seemed to be below the renal arteries, therefore the wound was enlarged upward to within two inches of the xiphoid and downward to about two inches above the pubis. The right rectus was retracted laterally, care being taken to protect the epigastric vessels from injury. The small bowel was packed off and the root of the mesentery of the small intestine was reflected off the aneurysm by blunt dissection. An area about the size of a dime in the middle of the aneurysm was found to be paper-thin. The third portion of the duodenum was bluntly freed and pushed upward from the aorta, proximal to the aneurysm. About one inch of the aorta above the tumor was exposed. The inferior mesenteric artery arose from the middle of the aneurysm which extended down to the origins of both common iliac arteries. The aorta was freed from the vertebral column with a blunt hemostat and a rubber band about ¾ inch wide

was placed under the vessel and sutured, in the shape of a funnel, with three No. 1 interrupted silk mattress sutures. The sutures were so placed that rubber interposed between them and the vessel, so that if the knots were to slip, the sharp stitches would rub on the rubber and not on the aorta. The lower end of the funnel compressed the aorta so that about three-fourths of the circulation into the aneurysm was interrupted, although there was still a distinct pulsation in the aneurysm and a thrill. The root of the mesentery was sutured back in place over the aneurysm and the wound closed in layers. The patient stood the procedure well. The blood pressure fluctuated around 100 systolic during the entire operation.

Postoperative Course.—Immediately postoperative faint pulsations were felt in both femorals, more marked on the left side. The legs were warm, and after the spinal anesthesia had worn off, there was no pain, and the muscles of both legs showed normal strength. On the day following operation, the aneurysm seemed to be pulsating about half its preoperative strength. Blood pressure was 138/70. He vomited several times, and a Levine tube was inserted, gravity suction applied, and fluids maintained intravenously. The night of the second postoperative day his temperature was 106° F., breath sounds were indistinct, and there were wheezes over both lower lobes. It was felt that the patient had a patchy atelectasis and sulfathiazole was administered. For the first week he showed evidence of partial small bowel obstruction, having a tendency to mild distension, with considerable high-pitched peristalsis. This gradually subsided, and on March 27 his general condition was good.

March 29, blood pressure was: right thigh, 140/80; left thigh, 150/100; right arm, 142/90; left arm, 144/90. Oscillometric readings: 2 at 120, 4 at 120, 9 at 110, 7 at 100.

All sutures were removed April 3, the wound healing by first intention. The patient was allowed out of bed and had no complaints.

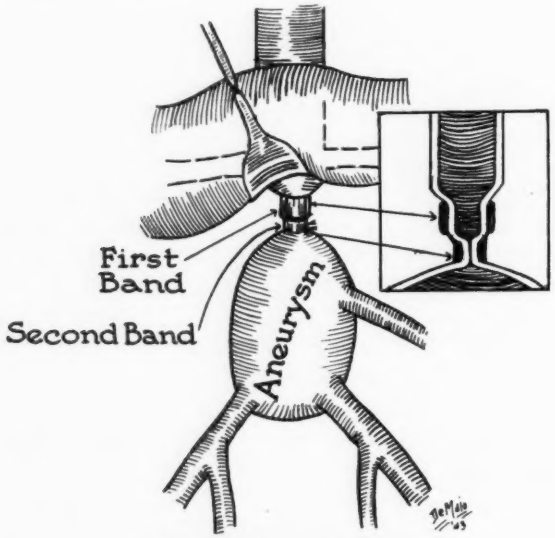
Second Operation.—April 11, 1942: Under 1½ mg. spinal pontocaine, an incision paralleling the one on the right side was made just to the left of the midline. Care was again taken to avoid injury to the epigastric vessels. On opening the peritoneum, two loops of small intestine were found adherent to the previous wound. These were freed. The root of the mesentery was dissected off the aneurysm, bluntly, considerable induration being encountered in these tissues. After the aneurysm was uncovered, the mesentery was dissected further till the third portion of the duodenum was met. This, in turn, was pushed upward, and the site of the previous ligation was exposed. The aneurysm was about the same size and pulsating, although not as strongly as before the partial occlusion. A curved clamp was inserted under the aorta just proximal to the aneurysm and a piece of rubber band ½ inch wide was brought under it, below the first band, and sutured with three fine silk sutures, so that the vessel was completely occluded. The aneurysm then did not pulsate, nor did the common iliac vessels. The patient's blood pressure did not change during this maneuver. However, it was noticed that the vessels arising proximal to the point of ligation, especially branches of the superior mesenteric artery, were more prominent and pulsated with considerable vigor. The root of the mesentery was replaced and sutured with interrupted silk sutures, and the wound was closed in layers with several heavy silk stay sutures for reinforcement. At the conclusion of the operation there were no pulsations palpable in the femoral vessels and the legs were somewhat cool.

Postoperative Course.—After anesthesia wore off, the left leg was warm to the toes. The right leg was warm to the knee and was progressively cooler toward the toes. There were fibrillary twitchings in the calf muscles of the right leg, none

in those of the left. The patient complained of a feeling of "pins and needles" in the right foot. He could move both legs without difficulty. The general condition was good.

April 12, there were no pulsations by oscillometer in either thigh. Power and motion were normal. There was diminished sensation in the right lower calf, ankle, and foot. The right foot was still cold.

The patient's general condition remained good. His bowels moved on the third day and he had no trouble with urination. The fibrillations in the right calf ceased after forty-eight hours, and the circulation in the right leg rapidly improved, so that after a week he had only a sensation of coldness in his foot. The wound healed by first intention. He was allowed out of bed on the thirteenth postoperative day and discharged from the hospital two days later.



SECOND STAGE

Fig. 2.—Circulation completely shut off by second band distal to the first.

Third Operation.—May 15, 1942: Under 1½ mg. spinal pontocaine, the incision on left side was excised and the peritoneum opened. A section of small intestine eighteen inches long was edematous, adherent to itself and to the abdominal wall. This was freed up to expose the field. The aneurysm was somewhat smaller and not pulsating, although it seemed to contain fluid material. The root of the mesentery was again dissected over the aneurysm, until the second rubber band just above the aneurysm was encountered. A curved clamp was placed behind the aorta at this site and two heavy silk ties placed but not tied. At this point, brisk bleeding was encountered, the source of which was not evident. It was controlled by pressure on the aorta, about two inches above the aneurysm. While this pressure was maintained, both common iliacs were isolated and cut about one inch below the aneurysm. Both ends were doubly ligated and allowed to retract. The heavy silk ties proximal to the aneurysm were then tied and pressure released. It was then noted that the inferior mesenteric artery had been torn about 1½ inches from its point of entry into the aneurysm. Blood was spurting from the mesenteric side of the vessel, which was clamped and tied. The root of the mesentery was again sutured in place and the wound closed in layers with heavy silk retention sutures. The blood pressure dropped to 60/40 during the latter part of the operation but returned to 140/80 after the administration of 500 c.c. of plasma.

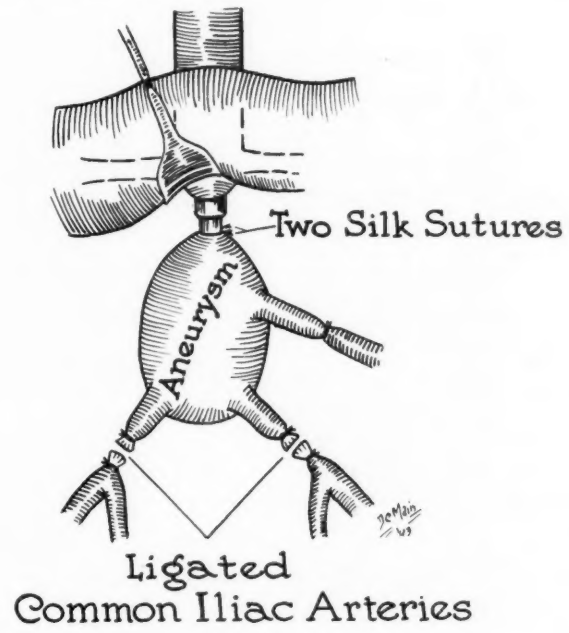
Postoperative Course.—May 16, general condition was good. The patient complained of pain and numbness in the right leg from the knee to the foot. Motions were good. The right lower leg and foot were colder than the left.

May 20, pain in the leg was somewhat better. There was a small amount of separation at the upper angle of the wound; the wound was strapped.

May 21, temperature was 104° F. There were fine râles over both lung fields. Sulfadiazine was given.

May 27, temperature was normal. X-ray picture of the chest showed central pneumonic process in the left hilar region.

May 31, all sutures were removed and the wound healed. The patient was allowed out of bed and discharged June 2.



THIRD STAGE

Fig. 3.—Two heavy silk ties placed distal to second band, both common iliacs divided and ligated, and inferior mesenteric ligated.

Subsequent Course.—The patient complained of pain in the right foot more or less continuously after discharge from the hospital. However, he was up and around and had no difficulty walking. The aneurysm was palpable only as an indurated area and the patient had no symptoms except the pain in the foot. There were never any pulsations over the femorals and no evidence of collateral circulation through the epigastric vessels. The advisability of lumbar sympathetic block was being considered as a possible aid to increase the circulation to the foot as it was felt that his pain was undoubtedly due to diminished blood supply. This foot was somewhat cooler than the left, but there was no impairment of nutrition to the tissues.

August 15, he had a sudden, severe hematemesis and passed considerable blood by rectum. On removal to the hospital his blood pressure was 90/70, pulse 120, red blood cells 2,000,000, and hemoglobin 40 per cent. He was given morphine, nothing by mouth, and no intravenous fluids. The following morning the blood pressure had risen to 100/70 and pulse was 90. Except for being weak and ap-

prehensive he had no complaints. There was no change in the shrunken abdominal mass. Suddenly, without warning, he vomited copious amounts of blood and died.

Autopsy.—The gastrointestinal tract was filled with blood. Careful search showed no lesion in the stomach or first portion of the duodenum. There was a pin-point opening in the third portion of the duodenum which connected directly with the aorta about ¾ inch above the aneurysm. Between this point and the aneurysm was a solid ring of tissue of cartilaginous consistency about ¼ inch in diameter, totally occluding the aorta. On the right side of the vessel just above this constriction was a new small aneurysmal dilatation filled with laminated clot. Two strands of silk were found incorporated in the tissue at the lower end of the constriction. The aneurysm was flat, about one-half its previous size, and on opening it, old organized clot was found. There was no circulation within it.

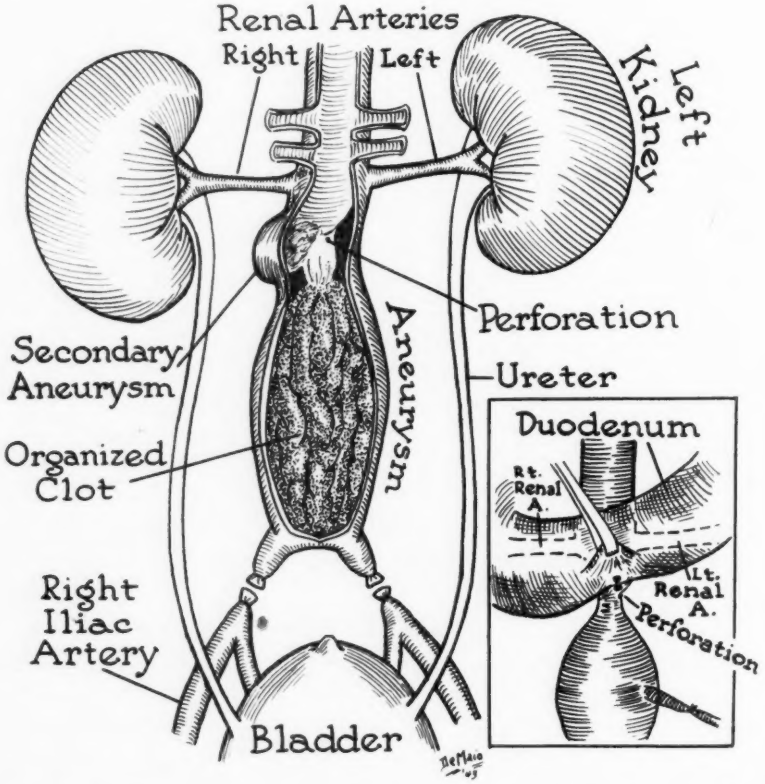


Fig. 4.—Autopsy specimen showing perforation into duodenum just proximal to upper rubber band at edge of small new aneurysm. White area is fibrous tissue of cartilaginous consistency which developed in region in which bands were placed. There is no lumen through this area.

The stumps of the common iliacs attached to the aneurysm were also filled with old clot. The distal common iliacs were both filled with organized clot, as were the external iliacs down to the femorals. The epigastrics were competent but not dilated. There were many small vessels which could be seen coursing over the pelvic peritoneum. There was no evidence of diminished blood supply to the sigmoid colon. Sections of the aorta showed syphilitic aortitis. The heart was not abnormal.

Comment.—Grossly, there was no evidence of the rubber bands. Microscopic sections disclosed that they had disintegrated and had become incorporated in the constricting scar tissue. It seems evident that the upper edge of the proximal

band had weakened the aortic wall. This deterioration had resulted in the aneurysmal dilatation on the right side and the eventual perforation on the anterior surface of the vessel. It seemed obvious that the collateral circulation had been maintained by branches from the hypogastric vessels. In spite of the adverse outcome of the case, it seemed remarkable that satisfactory circulation to the limbs could have been maintained after ligature of both common iliac arteries and the aorta above the inferior mesenteric artery. The large bowel undoubtedly obtained its blood supply from anastomoses with the branches of the middle colic artery. It must be concluded that the circulatory system possesses an amazing power of adaptability, at least in the lower part of the body, if partial interruption of the blood flow is accomplished as a preliminary measure. To my knowledge this is the first time that the aorta and both common iliacs have been ligated in the human being, with success as regards adequacy of the circulation.

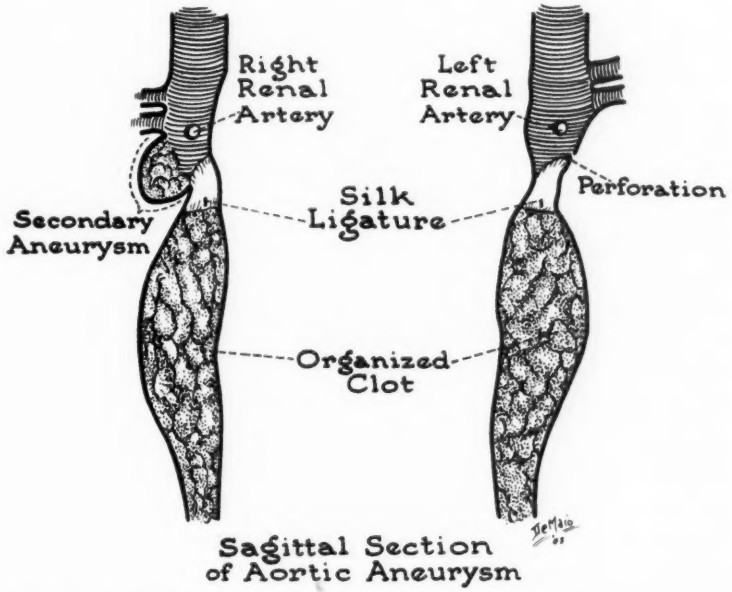


Fig. 5.—This is a sagittal section through the aorta and aneurysm showing the organized clot in the shrunken aneurysm, constricting fibrous tissue, silk ligatures, new aneurysm, and point of perforation. Also note relation to renal arteries.

ANALYSIS OF PREVIOUS CASES

Vaughan,[4] in 1921, reported partially occluding the aorta below the origin of the inferior mesenteric artery for an aneurysm lying above the origin of the superior mesenteric artery in a 39-year-old man. At Halstead's suggestion he used cotton tape and the patient survived for two years and one month. It is difficult to see how this procedure would have a beneficial effect on an aneurysm proximal to the ligation. Rather one would expect a deleterious effect.

In April, 1923, Matas[5] completely occluded the aorta below the inferior mesenteric artery in a woman, aged 28 years, for a leaking aneurysm of the terminal aorta. This was the first reported clinical cure of an aortic aneurysm by proximal ligation. The aorta was occluded by two cotton tapes. For the first week the patient was in a precarious condition, which was relieved, in the opinion of Matas, by the relaxation of the tapes and return of partial circulation through

the aneurysm. She died of progressive pulmonary tuberculosis one year, five months, and nine days after ligation, and at autopsy there was complete consolidation of the clot and shrinkage of the aneurysm. It is probable that a preliminary partial ligation would have avoided the stormy postoperative course of this patient. This, of course, would not have been feasible because the aneurysm had already begun to give way.

Watts,[6] in September, 1923, described a woman 60 years of age with a lower abdominal aneurysm treated by partial occlusion with cotton tape below the superior mesenteric artery. The patient lived three and one-half years. In 1926, Brooks[7] ligated the aorta distal to the inferior mesenteric artery in a man aged 59 years. The artery was completely occluded with fascia lata and heavy silk distal to the fascia. Brooks was convinced that considerable collateral circulation had been built up before operation, accounting for the absence of symptoms in the extremities following operation. Death from intestinal obstruction resulted after three months. Autopsy showed the aneurysmal sac completely obliterated by clot, and the aorta completely obstructed at the site of ligation by a well-organized thrombus.

LaRoque,[8] in 1930, reported partially occluding the distal abdominal aorta with tape and heavy silk in treating an aneurysm of the right common iliac artery in a patient 30 years of age. She was alive and greatly improved at the end of fourteen months.

The case described by Bigger,[2] in 1940, is unique because of the rarity of the lesion and the truly remarkable skill which effected a cure. He treated a ruptured aneurysm of the lower aorta, resulting from a gunshot wound in a youth 25 years of age, by complete proximal ligation with fascia lata and subsequent endoaneurysmorrhaphy. The feature of interest is that there was complete paralysis of both lower extremities of about two weeks' duration following complete occlusion, this gradually clearing over a two-week period. Obviously, it was necessary to occlude the aorta completely above the fistula because of the acute hemorrhage. However, the case demonstrated that complete occlusion, even in a healthy young adult, should be avoided if possible.

In 1940, Elkin[3] described partial occlusion of the aorta distal to the inferior mesenteric with cotton tape in a male, aged 50 years, with relief in symptoms and decrease in size of the aneurysm.

DISCUSSION

Thus we see that of these seven patients only three had total occlusions done in one stage. In the other four operative survivals partial occlusion had been done. In two of the cases of total occlusion in one stage, those of Matas and Brooks, collateral circulation existed at the time of operation. Matas states that collateral had been well established, and Brooks felt that a similar situation—both common iliacs

had been partially obliterated—was responsible for the benign course and cure of his patient. Whether or not collateral was present in Bigger's case is questionable. At any rate, the early postoperative reaction of his patient, paralysis of both extremities, suggested that only his youth and vascular adaptability allowed him to survive. In the early cases from the time of Cooper to 1920, patients who did not die of hemorrhage died of shock. This was no doubt due to the fact that total occlusion in one stage is not well tolerated by man.

The comparatively benign course of the patient I have described after a two-stage complete occlusion of the aorta, would seem to establish the fact that in the region of the lower abdominal aorta, at least, an occlusion in stages is distinctly feasible. It would seem likely also that many older patients could withstand total occlusion in stages from the standpoint of circulatory efficiency.

Gage[9] has stated that "all cases that have survived ligation with tape have demonstrated both clinically and at autopsy that the lumen has been partially restored." Brooks stated in 1926, "ligature of the artery proximal to the aneurysm as everyone knows, is usually not a satisfactory cure of aneurysm." If cure resulted in the cases of Matas and Brooks because both common iliacs were at least partially obliterated, I have shown that these conditions can be produced by deliberately dividing and ligating these vessels. It is difficult to conceive of circulation being re-established in my patient through the cartilaginous ring found proximal to the aneurysm, and of course, circulation from below could not be re-established with the iliacs divided. It would seem that proximal obliteration could very well cure aneurysms if material or a method could be obtained whereby healing of the vessel by fibrosis would occur without weakening of the vessel by the pressure of an occlusive band.

The pressure of the proximal rubber band in the case I have reported undoubtedly caused the small aneurysm just above the band on the right side of the aorta. Likewise pressure of the band caused the eventual perforation. Furthermore, in 28 of 75 dogs operated upon by Owings, the rubber bands cut through the vessel. It would seem fair to conclude that rubber is not a safe material with which to occlude the aorta. Owings states that it does not seem likely that aneurysms in man can be successfully treated by proximal ligation, because of the likelihood that the vessel walls are diseased and unable to tolerate ligation. It is worthy of note, however, that in the cases of Vaughan, Matas, Watts, LaRoque, and Elkin, cotton tape was used, and in none of these did the tape cut through the vessel wall. Matas demonstrated histologically that cotton tape is well tolerated by the tissues of the aortic wall. In his case no ulcerative, thrombotic, or necrotic changes were observed beneath the tape. Three of these cases were due to syphilis of the aorta and presumably the vessel was not entirely healthy. These patients were not all young—one was

39 years of age, one 59, and one 60. The patient I have reported was 49 years old. These facts suggest that cotton tape is the best material for proximal ligation at the present time. Tape could certainly be used in the preliminary partial ligation, and it is likely that cure would result with a second occluding ligation with tape and division and ligation of the iliacs. It seems clear, however, that a more physiologic technique should be developed for permanently occluding the vessel than the use of strangulating ligatures. When we consider the aorta as a living structure it is immediately realized that the blood supply on which we are dependent for repair and permanent healing has been compromised by this procedure. Possibly a preliminary partial ligation with cotton tape, then division of the vessel at the second stage, traumatizing of the intima and suturing its surfaces together with parallel rows of fine sutures, or some similar procedure, would be the answer. J. S. Horsley, Jr.,[10] has shown that vessels heal with greater degree of fibrosis when they are divided, receiving additional nutrition from the surrounding tissues. This problem still awaits solution.

SUMMARY AND CONCLUSIONS

A case is reported in which the aorta was occluded in stages by rubber bands proximal to an aneurysm with division of both common iliac arteries. The patient lived approximately five months from the time of the first ligation. Seven cases of aortic ligation are reviewed. Of these, there were four partial and three total occlusions. Of the three total occlusions, three patients had collateral established at the time of operation and the third had alarming paralysis of the extremities following ligation, and survived probably because of his youth.

Occlusion of the lower abdominal aorta is feasible. Furthermore, man will tolerate division of both common iliacs after ligation of the aorta. Cotton tape has been demonstrated as the least noxious material for ligation. It seems reasonable that ligation in stages with cotton tape, plus ligation of both iliacs, should cure aneurysms of the lower abdominal aorta.

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THE PHYSIOCHEMICAL DISTURBANCE IN A SEVERE BURN*

BERNARD J. FICARRA, M.D.,† AND EMIL A. NACLERIO, M.D.‡
BROOKLYN, N. Y.
(From the Department of Surgery, Kings County Hospital)

INTRODUCTION

UNIVERSAL interest in the subject of burns has always captivated the attention of surgeons. The voluminous literature on this subject clearly indicates that interest is never waning. The majority of authors writing on this subject concern themselves with definitive treatment, the associated shock, fluid balance, and similar topics. The most neglected phase of the burn problem has been the physiochemical disturbance produced by tissue destruction. The changes reflected in the circulating blood due to severe burns in a human being have been studied rarely. Most of the data known to us have been gathered from animal experimentation. In the treatment of burns the opportunity and facilities were available to us on one occasion for a detailed and continual physiochemical observation of a severely burned patient. In view of the fact that few complete chemical analyses have been made in clinical burns, the following case report was considered significantly valuable.

CASE REPORT

The patient was a 43-year-old white male employee of a public utility company. While working at the top of a forty-foot pole, his clothing became inflamed from sparks which arose from the wire he was repairing. By the time he reached the ground his clothes were a mass of flames. His clothing was removed and tannic acid applied to the body surface by members of the fire department. He was then taken to the hospital.

On admission the patient was in clinical shock from diffuse burns involving 60 per cent of his body surface. There were third degree burns of both thighs, second and third degree of right arm and forearm, and first and second degree about both ankles. In addition he had a fracture of the left ankle. At this time his temperature was 99.6° F.; pulse, 120; respirations, 26; blood pressure, 90/50.

Nine hours after admission the patient had responded sufficiently from shock to permit treatment of the burn. One hundred cubic centimeters of whole blood were taken for study immediately after entrance. For the first sixteen hours blood chemistry studies were done every four hours. Thereafter complete studies were made every day. On the seventh postburn day the only available vessel for obtaining a blood sample was the internal jugular vein. This was due to the fact that the burn areas prevented the use of many vessels, others became thrombosed, and on that day the patient became edematous.

On the ninth postentrance day the patient's temperature rose to 102° F., and he became delirious. Two days prior to this a toxic erythematous rash become

*Presentation of this case is made possible through the kindness and cooperation of Ralph F. Harloe, M.D., F.A.C.S., Assistant Clinical Professor of Surgery, Long Island College of Medicine, Brooklyn, N. Y.

†Fellow in Surgery, Lahey Clinic, Boston, Mass.

‡Fellow in Thoracic Surgery, under Dr. R. H. Overholt, Brookline, Mass.

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visible on the nonburned skin surfaces. The patient expired on the tenth hospital day in spite of the general therapy of whole blood, plasma, fluids, adrenal cortical extract, vitamins, chemotherapy, proteins, and local treatment of the burn areas.

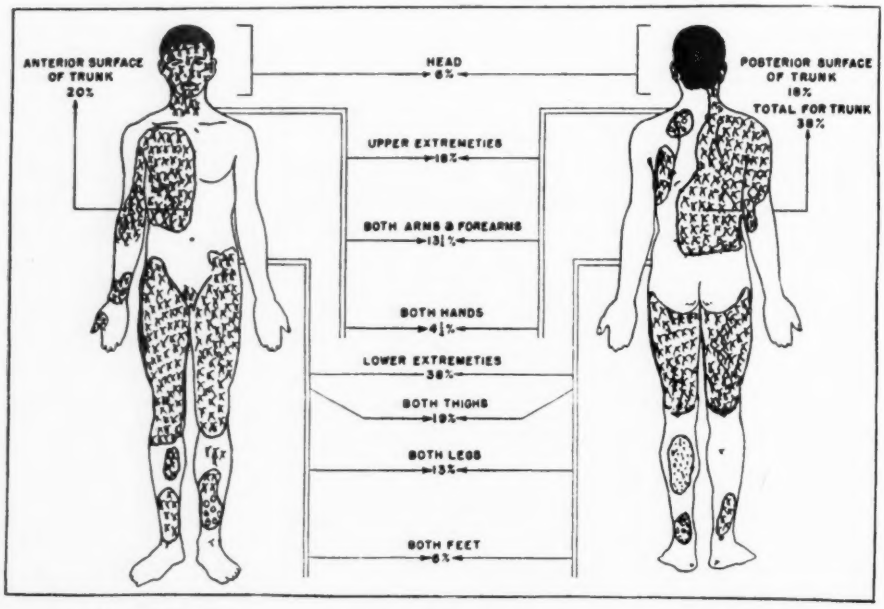

Fig. 1.—Chart illustrating percentage of body surface burned according to degree of the burn.

Autopsy Findings.—We were fortunate in this instance to secure an autopsy.* The anatomic findings were as follows:

1. Primary diffuse third degree burns of the head, chest, back and upper and lower extremities
2. Pyoderma with ulceration
3. Bilateral acute and chronic interstitial pyelonephritis and nephrosis
4. Bilateral adrenal hemorrhage
5. Passive congestion of the liver
6. Hemorrhagic cystitis
7. Acute tracheitis
8. Ulcerative esophagitis
9. Mucosal hemorrhage throughout the gastrointestinal tract
10. Cardiac hypertrophy with right ventricular dilatation
11. Pulmonary edema
12. Chronic cholecystitis with calculi

The significant pathologic findings were revealed in the study of the skin, kidneys, liver, and adrenal glands. Of these four organs the most interesting findings were noted in the kidneys.

Grossly the kidneys were extremely large. The right one weighed 470 Gm.; the left, 380 Gm. The capsule was thin and stripped easily. The underlying cortical surface was reddish brown in color with readily demarcated cortex and medulla. The glomeruli were grossly prominent.

*Permission for necropsy study was obtained through the efforts of Dr. Robert F. Barber, Professor of Clinical Surgery, Long Island College of Medicine.

Microscopic examination of the kidneys demonstrated the glomerular spaces to be distended with albuminous deposits. The cytoplasm of the tubular epithelium had a ground-glass appearance, especially in the proximal convoluted tubules. Many tubules contained albuminous material. A marked interstitial edema with scattered localized areas of hemorrhage was present. The renal pelvis, medulla, and isolated cortical regions showed dense collections of lymphocytes, plasma cells, and fibrin. The capillaries showed a pronounced dilatation and engorgement.

Pathologic histology of the liver showed a generalized dilatation and engorgement of the sinusoids. The liver cells indicated passive congestion. Lymphocytic nests with occasional polymorphonuclears were seen about the portal region.

The adrenal glands retained their normal histology. However, the zona reticularis of the medulla contained hemorrhagic areas. The cells had a coarse ground-glass appearance. Marked interstitial edema was seen in all the zones of the medulla.

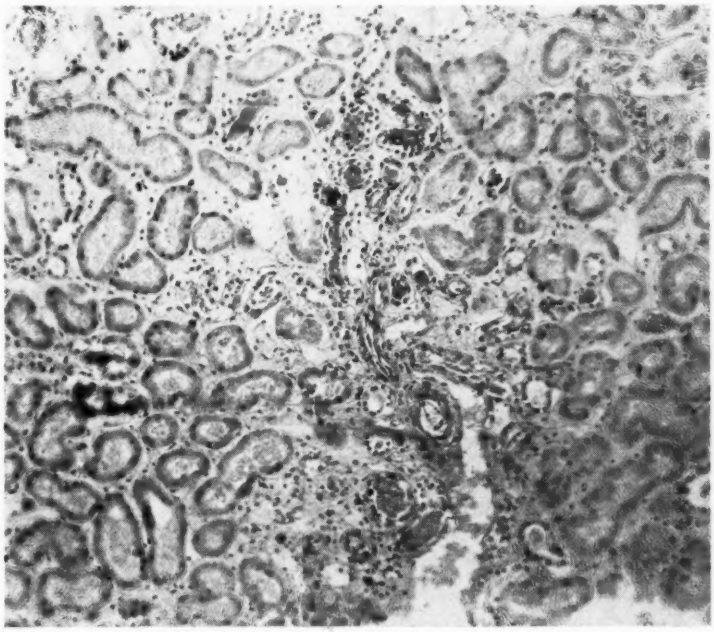

Fig. 2.—Photomicrograph of kidney showing albuminous material in tubules and interstitial hemorrhage. Some tubules contain red blood cells. (×100.)

GENERAL DISCUSSION ON CHEMICAL CHANGES

It has been generally accepted in the past that in extensive burns a toxic state results due to injurious elements produced by burned tissues. The quantity of liberated toxic substances which passed into the circulation was believed to be proportional to the extent of the burn. The exact nature of this toxic substance has never been determined. Formerly it was thought to be derived from the albumin of the cell and was suspected to be a polypeptide. Death was attributed to toxic physiopathologic alterations in the internal organs due to this proteid substance.

Our experience with burns has led us to believe that the question cannot be answered simply by stating that toxicity is the cause of

physiologic dysfunction. Heretofore minimal consideration has been given to the physiochemical changes in burns. In 1924 Davidson studied intensively the sodium chloride metabolism in burns.[1] This was the first time that an evaluation of the blood chemistry found a

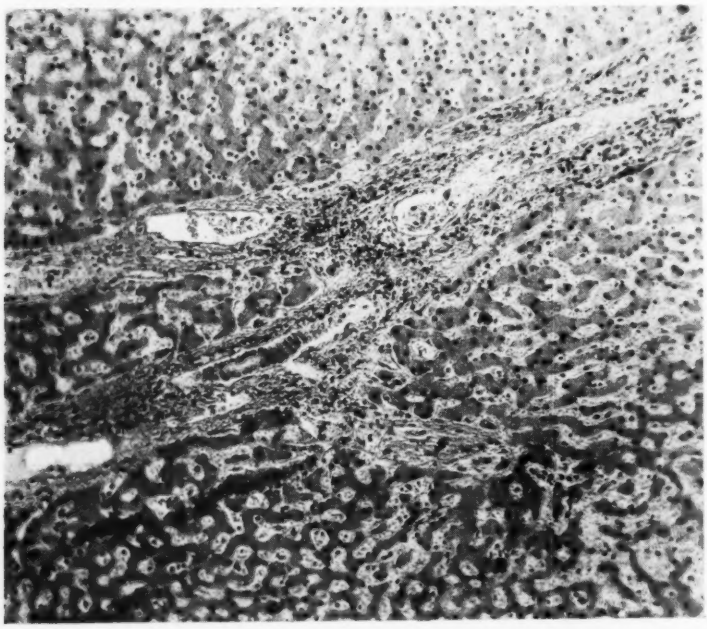

Fig. 3.—Section of liver demonstrating central veins congested with red blood cells. Collections of lymphocytes are seen about portal areas. Evidence of passive congestion is present. (×100.)

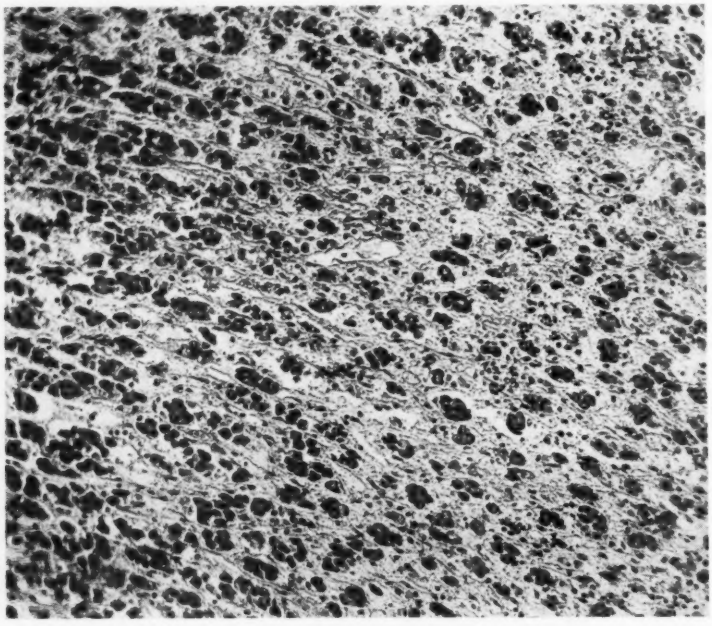

Fig. 4.—Adrenal gland showing marked hemorrhage in the zona reticularis. (×100.)

prominent place in the discussion of burns. He found a significant lowering of the chlorides which was believed to be due to a lowering of plasma chlorides below the renal threshold rather than to a primary kidney change. It was further observed by him that the chlorides did not fall immediately after the burn but diminished progressively during the first few days.

Harkins believes that fluctuation in the blood chloride values is more pronounced than blood sugar changes.[2] Chloride changes are attributed to a selective permeability of the burned capillaries for smaller molecules. Scudder studied a severe burn case as to chlorides.[3] These values were slightly above normal on admission of the patient and were so maintained. On the fourth day a decrease below normal occurred. By the eighth day, the chloride values reached a small peak. Roughly, the changes in chloride concentration paralleled the fluctuations in sodium.[3] Accentuated interest has been given to sodium in cases of severe burns. Fox, in a recent publication, has stressed the importance of sodium in the rational treatment of the burned patient.[4]

The alterations in plasma protein values with a shift in the albumin-globulin ratio and its association with the production of edema have been emphasized recently. This has been attributed to the loss of blood fluids through the burn areas. It is believed that in such cases albumin may be lost in slightly greater quantities than globulin.[2]

Observation of the blood chemistry during burns by Beck and Powers was the first evaluation of the nonprotein nitrogen.[5] These observers noted an increase in nonprotein nitrogen. In later postburn studies a rise in creatinin and uric acid was recorded. The increase in these products was attributed to renal tubular damage.[6]

All writers experienced in the management of burns recognize the initial hyperglycemia. This elevation of blood sugar has been attributed to adrenal stimulation. The rise and fall of the blood sugar level parallels the degree of hyperadrenalism. Fatigue of the adrenal glands and the exhaustion of adrenalin secretion are reflected in the diminution and rapid fall into a lethal hypoglycemic state.

Evaluation of blood concentration and acidosis have been stressed in burns. Hemoconcentration almost always follows a burn. This state results from fluid loss from the burn surfaces and the retention of fluids plus crystalloids within the body tissues. Such hemoconcentration is either a cause or a result of some serious disturbance in the physiologic regulation of the human body.[2] Since 1903, when Stockis called attention to a decrease in the carbon dioxide content of the blood following experimental burns, the tendency toward acidosis in these patients with burns has been recognized.[7] This finding has been corroborated by many subsequent investigators. Lam (1941) observed a decreased carbon dioxide combining power as low as 20 to 25 volumes per cent in patients who died.[8] These are among the lowest values recorded in the literature. He further observed no beneficial effect from the administration of sodium bicarbonate to such patients.

Thus in brief is the present concept of the physiochemical background in diffusely burned patients. The elucidation of this problem has been accelerated in recent decades, although the answer has not been reached as yet. Many burn researchists have given minimal consideration to this problem in spite of the fact that interest in blood chemistry alterations in burns was recorded as early as 1863.[8]

PROBLEM OF FLUID BALANCE

The major concern in the treatment of burn shock is the administration of intravenous fluids that will restore the blood volume and its physiologic components to near normal level. The preference for plasma is based upon the fact that extensive burns are followed by exemia and cellular concentration of the blood. Harkins devised a simple method of calculating plasma dosage. His formula is to give 100 c.c. of plasma for every point the hematocrit is above the normal of 45.[2]

English authors have employed sodium bicarbonate infusions with the objective of combating acidosis. When this solution is employed, the danger of azotemia from alkalosis is to be remembered. It has been stated that "Intravenous injection of crystalloids such as sodium chloride should be avoided for they are quickly lost from the circulation, carrying with them a part of the plasma."[15] A statement such as this is worthy of notation even if it is open to debate.

As a result of hemoconcentration, acidosis, and sluggish pulmonary circulation, oxygenation of arterial blood becomes increasingly inefficient. "Tissue anoxia with a compensatory hyperventilation occurs which increases the rate of fluid loss. This in turn produces a reduction in plasma volume and the hemoconcentration increases."[16] With this thought in mind, "the beneficial effect of transfusions in burned patients in all probability is due as much to the additional oxygen-carrying material thus supplied as to the replacement of lost serum protein and blood electrolytes."[16]

The use of whole blood has added value in the treatment of the anemia associated with burns. The development of secondary anemia occurs after the first or second week, especially in third degree burns. These burns with raw granulating surfaces are associated with blood loss due to infection and small local hemorrhages. Another etiological factor in the production of the anemia may be a toxic depression of the bone marrow. As a result of the disturbance in capillary permeability in these traumatized tissues and in the gastrointestinal tract, an extravasation of blood serum with many red cells occurs. Where diffuse gastrointestinal hemorrhage occurs, an additional loss of blood results.

The work of Schievers indicates that due to red cell destruction or other factors, a decrease in red blood cells occurs soon after a burn.[17]

"The important fact about Schievers' data is that the decrease in blood volume was greater than the plasma loss would account for and must be accompanied by a decrease in red cells as well. It has been said that transfusion is not indicated in burn shock since the blood is already concentrated. It is to be pointed out that the presence of a high blood concentration would not be a valid argument against transfusion. This is true because the donor blood is dilute in comparison to the patient's blood."[2]

CASE DISCUSSION

With the aforewritten background we are prepared to discuss the information revealed in the data acquired from the case presented.

Our observations have led us to believe that an evaluation of the blood chlorides is extremely important. It cannot be definitely stated that the most important ion is the chloride ion or whether the sodium ion is the one to be stressed. Scudder emphasizes the fact that a rise and fall in chloride values parallels the alterations in sodium values.[5] Fox has stressed most emphatically that the sodium ion plays the master role in the electrolyte balance.[4] Which ion has the major role cannot be stated at present. Immediate treatment of incipient burn shock with chlorides and sodium may be changed according to the work of the authors just mentioned.

In the case presented changes in the blood chlorides were not very remarkable. However a significant fall in value occurred on the fifth postburn day (from 600 to 480 mg. per cent). This fall on or about the fifth day has been noted by other observers.[3, 4, 18] This suggests that the critical period in ionic disturbance may occur on or about that day. Such profound alterations may indicate a "break" in the biochemical compensation on the part of the human body. On this day especially an evaluation of the blood chlorides and sodium seems to be of paramount importance. The administration of large volumes of sodium on this day may be the necessary factor in the prevention of biochemical decompensation.

As a generality the value of sodium paralleled the chloride determination. All the sodium values on all occasions were below the normal of 142. On the fifth postburn day a decided fall in the plasma sodium was noted for the first time: The value was 129.2. On the eighth and ninth days the values were lower: 122.4 and 123.7, respectively. The fifth day corresponds to the period when the biochemical decompensation occurred. On the eighth day clinical evidence of the patient's inability to maintain an adequate water balance was visible.

On the eighth postentrance day the patient developed marked anasarca. This production of edema again reveals the importance of sodium and blood protein. No significant early alteration occurred in the total protein value, although a slight fall was recorded. Three

days before the onset of clinical edema a fall in total protein to 3.5 Gm. was found. A low value persisted to the eighth hospital day. In this instance a fall in blood protein occurred several days before the onset of visible edema. A daily evaluation of the albumin-globulin ratio may warn against incipient edema. With this knowledge available, edema may be avoided by means of protein replacement therapy.

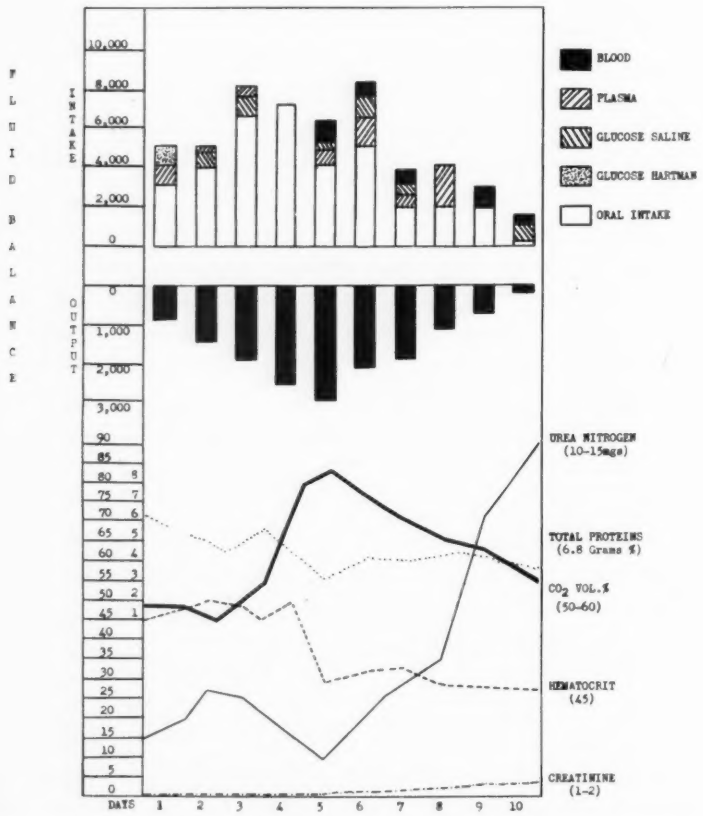

Fig. 5.—Composite chart illustrating fluid balance in association with blood chemistry values and hematocrit studies.

Another index of protein loss is estimated by the nitrogen excreted. Estimation of the blood urea nitrogen demonstrated a gradual, then a rapid, daily rise, finally reaching 90 mg. per cent on the tenth post-burn day. The nitrogen excretion was very high so that the patient's nitrogen balance could not be restored even though large volumes of proteins were administered. In this patient the total nitrogen loss could not be calculated exactly. This was due to the fact that much nitrogen was lost through the feces and through the burned skin areas. Toxic destruction of protein is usually attributed to fever in the burned patient. In addition to fever, other factors associated with nitrogen metabolism must be sought for protein destruction in diffuse burns.

TABLE I

RESULTS OF DAILY BLOOD STUDIES AND SPECIAL TESTS PERFORMED IN CASE PRESENTED

DAYS	TIME	CHLORIDE	PLASMA SODIUM	SUGAR	TOTAL PROTEIN	ALBUMIN	GLOBULIN	CREATININE	UREA N	UREA	CO_2	HB. (GM.)	R.B.C.	W.B.C.	HEMATOCRIT	CEPHALIN FLOCCULATION	CHOLESTEROL	CHOLESTEROL ESTERS	ICTERUS INDEX	P.S.P. TEST
1	4:00 P.M.	608	140.8	561	6.3	4.4	1.9	1.50	18.1	38.7	48.5	13.5	4,6	22,000	45		180	110		
	7:00 P.M.	615	135.4	336					18.8	40.2		15.0	4,6	23,000	52					
	12:00 P.M.	605	133.8	298					18.6	39.6			4,8							
2	2:00 A.M.	602	135.4	223	5.8	3.7	2.1	1.90	28.2		41.9	15.5		25,000	48		184	102		
	10:00 A.M.	600		151	4.7	3.1	1.6		27.2		48.5	10.5	3,8		50					
3	8:00 A.M.	600	133.8		5.7	3.8	1.4		27.8			11.0	3,8		45		172	98		
	3:00 P.M.											11.0	3,6							
4	10:00 A.M.											10.0	3,2	8,400	48					
5	7:30 A.M.	480	129.2	102	3.5	2.4	1.1	1.35	11.3		84.3	10.5	3,4		30	Neg.	163	98	3.5	
	4:00 P.M.	565		132				1.35	15.0				2,9			Neg.			3.5	
6	7:30 P.M.	511	134.2	176	4.4	2.6	1.8	1.50	15.9		78.7	10.0	2,2		32	Neg.			3.5	
7	7:45 A.M.	507	131.2	116	4.0	2.7	1.3	1.75	30.6		76.8	11.0	2,5	10,100	33	Neg.				No dye
8	7:30 A.M.	480	122.4	83	4.3	3.0	1.3	2.30	38.2		67.3	10.0	2,480	12,000	29	Neg.				No dye
9	7:45 A.M.	494	123.7	123	4.5	2.9	1.6	3.60	69.0		61.7	10.0	2,5			Neg.	160	57		No dye
10	7:45 A.M.			211				4.00	90.0		54.1	10.0	3,100	12,600	28	Neg.	132	57		No dye

A second observation in reference to the blood nitrogen status in this patient was that it pointed to a renal derangement. A preuremic state may have existed in spite of the adequate output of urine. Urinalyses failed to reveal any unusual findings.

The disturbed carbohydrate metabolism in this patient was reflected in the study of the blood sugar. A review of the blood studies demonstrates an immediate hyperglycemia of 561 mg. per cent. The hyperglycemia gradually diminished, returning to normal eighteen hours after admission. The immediate hyperglycemia following this severe burn suggests that glycogenolysis can occur which may deplete the liver of its glycogen reserve. It is logical, therefore, to administer glucose in order to replenish the liver glycogen, in spite of the existing hyperglycemia.

Associated with the blood sugar determinations are the adrenal relationship and the problem of acidosis. The parallelism between the fluctuating blood sugar and the pathologic changes in the adrenal glands has been studied intensively by others.[13] The gradual-developing adrenal insufficiency leads to blood pressure alterations in addition to disturbed carbohydrate metabolism. Often this irreparable fall in blood pressure occurs on or about the fourteenth day and is a contributing death-producing factor due to adrenal exhaustion.

The problem of acidosis in burns gives rise to the assumption that the disturbed carbohydrate metabolism may be interpreted as the underlying cause. The possibility presents itself that the so-called burn "toxicity" may be an expression of some intermediary metabolism leading to acidosis.

In our patient the carbon dioxide combining power eight hours after admission was 48.5 per cent. Eight hours later the value was 41.9 per cent, showing a tendency toward acidosis. This tendency continued. For the third and fourth postburn days (a week end) no facilities were available for carbon dioxide determinations. At this time the patient was given citrocarbonate, 1 dram every four hours for twenty-four hours, plus 100 c.c. of lactated Ringer's solution. On the fifth postburn day (a Monday) the carbon dioxide combining power rose to 84.3 per cent. This demonstrated that our patient had alkalosis. With the knowledge of Lam's work at our disposition, we were at a loss to explain this phenomenon,[8] for it will be recalled he wrote that no beneficial effects could be found by administering carbonates in burn acidosis. It was then thought that the fifth day may again be incriminated as the critical period in the ability of the body to combat a physiochemical decompensation.

As a general statement it may be said that hemoconcentration develops soon after an extensive burn. The alteration in the blood concentration and dilution was often considered as a prognostic sign. These changes in concentration and dilution have formed a basis for the administration of plasma. In the management of this patient we

followed as far as possible the method of Harkins.[2] The hematocrit demonstrated hemoconcentration for the first five days. Thereafter hemodilution was present until death. Hematocrit evaluations alone are not accurate indices. Such evaluations are more useful when employed in association with a red cell count, hemoglobin determination, and a knowledge of the urinary output.

Blood picture studies revealed the onset of anemia within eighteen hours after injury. Hemoglobin values fell from 15.5 Gm. to 15 Gm. to 10.5 Gm. within these hours. During this time the hematocrit failed to demonstrate any deviation from the normal ratio.

On the sixth postburn day melena was noted for the first time. In view of the autopsy findings this can be attributed to gastrointestinal hemorrhage. On the seventh postburn day the patient's bowel movements were very bloody and continued to be so until death. On the seventh day a rash developed over the normal skin surfaces. Dermatologic consultation labeled the rash as a toxic erythema. The question is brought forward as to whether or not this toxic erythema was not subcutaneous hemorrhage corresponding to gastrointestinal hemorrhage. When the initial rectal bleeding was observed, a marked anemia was present. The red count was 2,200,000; the hemoglobin, 10 Gm. Both values were persistently low until death.

The low blood count and hemoglobin indicated that the oxygen-carrying capacity of the blood was one-half its normal potentiality. On the sixth day the patient had respiratory distress which demanded oxygen therapy. This distress was attributed to ischemic anoxia resulting from the lowered red cell volume.

Observation of this patient has shown that a sharp and sudden rise or fall in the red cell count and hemoglobin should suggest the necessity for additional fluids, plasma, or whole blood as indicated. Over a ten-day period this patient received a total fluid intake amounting to 41,920 c.c. Of this total, 16,200 c.c. were given parenterally. The solutions used were as follows:

Glucose in saline	5,000 c.c.
Glucose in Hartmann's	1,200 c.c.
Plasma	6,900 c.c.
Whole blood	3,100 c.c.
	16,200 c.c.

Notwithstanding the continual observation and treatment of this patient, he succumbed to the injury ten days after the accident. In a search for the cause of the patient's death the five major causes of death in severe burns were considered. These are shock, infection, hepatic insufficiency, adrenal exhaustion, and renal failure. Death in this instance could not be assigned to shock or infection. The cephalin flocculation test on seven occasions was negative. The icterus index was 3.5 on three successive days; a slight fall in cholesterol esters was

noted. These affirm that the liver function was apparently satisfactory. Autopsy studies substantiated the fact that the liver was not the cause of death.

Death may be attributed to adrenal exhaustion and renal failure. These organs are indicted in view of the blood chemistry studies, the phenosulfonphthalein test on the last four days of life, and the pathologic changes found in these organs at necropsy.

This case has emphasized that the intelligent management of the severely burned patient demands daily biochemical diagnostic studies. The facility with which an altered physiochemical state occurs merits constant checking of the blood chemistry. Therefore it can be stated that biochemical determinations are equally as important as therapeusis and the definitive treatment of the severely burned.

SUMMARY AND CONCLUSIONS

1. Metabolic and chemical data are presented in a case involving fatal burns.

2. This case illustrates sodium chloride changes, hypoproteinemia, destruction of body protein, alterations in carbohydrate metabolism, and hemoconcentration.

3. The acidosis which usually accompanies the burn syndrome was absent. An unexpected alkalosis occurred following the administration of citrocarbonate on the fifth postburn day.

4. Emphasis is placed upon a study of the blood chemistry on or about the fifth day. At this time a break in the biochemical harmony occurs. This discord is manifested in an elevation of the end products of nitrogen metabolism associated with a fall in serum proteins, plasma sodium, and blood chlorides.

5. In the treatment of this patient, 16,200 c.c. of fluids were administered parenterally. Of this amount, 6,900 c.c. were plasma and 3,100 c.c. were whole blood.

6. Death on the tenth day was attributed to adrenal exhaustion and renal failure.

7. The major factor leading to the cause of death in burns has not been established satisfactorily. It is believed that a severely burned patient dies of physiologic exhaustion. Therefore a study of the organs involved in this disturbed physiology (liver, kidneys and adrenals) will assist in the elucidation of the problem of the unknown lethal factor.

8. Herein lies the intrinsic value of serial studies of the physiochemical changes in the burned body as reflected in altered blood chemistry.

9. The exhaustion of the aforementioned basic physiologic organs may be the cause of death when, after the second week, the patient seems to be improving.

10. This somatic distress is emphasized because during the third week the initial danger apparently has been overcome. The anxious

surgeon considers the patient sufficiently improved for a skin graft. However, the disturbed chemistry has not been restored. In the presence of this metabolic discord, the administration of an anesthetic plus the surgical procedure may be sufficient to cause death.

11. In view of the presented facts, the thought is advanced that repeated examinations of the blood are necessary guides to the intelligent management and treatment of the severely burned patient. Without these studies one cannot know whether or not the desired results are being achieved.

12. Whenever possible the laboratory studies should include a daily red blood count, hemoglobin, urinalysis, and blood chemistry determinations (proteins, sodium, chlorides, nonprotein nitrogen, icterus index, and carbon dioxide combining power).

We wish to express our gratitude to Dr. S. Potter Bartley, Assistant Clinical Professor of Surgery, Long Island College of Medicine, for his guidance in the clinical management of the patient described in this report. Additional indebtedness is acknowledged to Mr. John C. Knight for his cooperation in the production of the charts and photomicrographs.

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LEONTIASIS OSSEA COMPLICATED BY MARJOLIN'S ULCER

Observation of a Case for Twelve Years

Ray E. Burger, M.D.,* Welch, W. Va., and Edwin P. Lehman, M.D.
Charlottesville, Va.

(From the Department of Surgery and Gynecology, University of Virginia School of Medicine, Charlottesville, Va.)

Virchow,[8] in 1896, applied an old term, leontiasis, which had been used to designate nodular changes in the soft parts of the face of the leper, to cases presenting hyperostosis of the skull, adding the adjective, ossea. The term leontiasis ossea is descriptive of appearance, not of pathology.[4] Most early reports of the disease are on museum specimens, about which clinical data are meager. The first of these was in 1700 by Malpighi in the *Opera Posthuma*. The present paper reports an instance of leontiasis ossea, seen first in 1930 and last in 1942, complicated by epidermoid carcinoma arising in a buccal fistula of seventeen years' duration.

Clinically, leontiasis ossea is characterized by slowly developing bony deformity of the face usually beginning in early life. There need be no other symptoms and signs unless the bony overgrowth impinges on the air passages of the face or upon various cranial nerves, in which case corresponding symptom complexes will develop. The syndromes resulting from encroachment on these structures bear the general name of craniostenosis.

In addition to infections around the nose, sinuses, and teeth, toxins, syphilis, trauma, and endocrine dysfunction have been proposed as etiologic agents. The malady has been compared with acromegaly and with Paget's disease. In leontiasis ossea the pathologic process is limited to the bones, whereas in acromegaly, both soft and osseous tissues are involved. Paget's disease occurs at an advanced age and is seldom localized to the head. Boyd,[1] however, has stated that leontiasis ossea and Paget's osteitis deformans are expressions of the same disease.

Eden[2] includes leontiasis ossea among the fibro-osseous tumors of the skull and facial bones under the general term of diffuse osteomas. He regards them as true benign tumors, but admits the possibility that infection and trauma may act as irritative factors to initiate the process. The characteristic changes are the replacement of the bone marrow by fibrous tissue and, later, an excessive formation of new bone in this fibrous tissue.

*Grace Hospital.
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In 1923, Lawford Knaggs[3] collected thirty-four cases, and reviewed the subject in detail. He divided the disease into cases of chronic periostitis, spreading slowly from bone to bone, to which the title of "creeping periostitis of the bones of the face and skull" was given, and cases of "diffuse osteitis of the bones of the face and skull." The periostitic form has its origin in the nasal fossae or sinuses, with large deposits of new subperiosteal bone as the inflammatory process creeps from bone to bone. The osteitic form was divided into (a) general, (b) circumscribed, or (c) local. The inflammatory changes were considered to be in the medullary portions of the bones. Knaggs believed the latter variety to be osteitis fibrosa affecting the cranial and facial bones. This opinion was expressed before the relationship between hyperparathyroidism and osteitis fibrosa cystica was understood and is, therefore, the result of clinical and pathologic observation only.

The disease usually affects the maxilla, malar bone, ethmoid and nasal bones, less frequently the sphenoid bone, parietal bones, and mandible, according to Mayer.[5] The involvement may be unilateral or bilateral. Ruppe[7] reported involvement of the first two cervical vertebrae.

X-rays reveal a general thickening of the bone. Mayer[5] listed the roentgen signs as follows: (1) There are considerable thickening and increased density of the bone, the thickening being intense and uniform. (2) The surfaces of the affected bone are entirely smooth and sharply defined. (3) The disease does not go beyond the anatomic margins of the bone or of a part of the bone if the latter has developed from more than one bony anlage.

Monti[6] has classified the disease as follows:

> (1) *Leontiasis ossea facialis autonoma:* This constitutes the true type of the disease, affecting the young, represented by a slight productive periosteal change, beginning in the superior maxilla, limited in localization to the bones of the face and characterized by an extremely insidious progress. Histologically there is eburnation of the compact portion and of the spongy bone due to a disappearance of the osseous medulla. The nutrient vessels maintain their activity in nourishing the new osteoblasts and osteocytes. In this form of the disease there is a definite lack of a corresponding activity of bone absorption. (2) *Leontiasis ossea syphilitica:* This type differs from the preceding form in that it extends to involve the entire skull very early in the disease. Inasmuch as this form also affects the very young, symptoms of craniostenosis are frequent. (3) *Leontiasis ossea craniofacialis of osteodystrophia fibrosis:* More commonly this form, also occurring in the young, affects the interior of the skull, but it may also produce the characteristic external deformity of the disease. It differs essentially from the other forms in that the process begins in the osseous medulla, which becomes fibrous, while the lacunas become resorbed and the superficial compact zone becomes localized where the osteoclasts are present in large numbers. (4) *Leontiasis ossea of osteitis deformans:* In this type the deformity results from a rarifying osteitis and a process of condensation, which alternate. The latter is predominant and leads to an osseous hyperostosis, which is characterized by an intense irregularity of the disposition of the lamellar system.

Leontiasis ossea is rare and complete post-mortem studies are even rarer. All opinion in regard to the etiology of the disease and the nature of the pathologic process seems to be speculative, based on analogies with other bone disturbances. A review of the literature is profitable only in furnishing data on the clinical manifestations and the anatomic extent of this curious condition.

CASE REPORT

G. V. M. (Hist. No. 86693), a white man, aged 28 years, was admitted to the University of Virginia Hospital Dec. 8, 1930, with a history of having a very large lower jaw all of his life.

The family and past histories were irrelevant, except for a fracture of the left femur in 1920 repaired with a silver plate. There was a fracture of the same bone in 1929 treated by closed reduction.

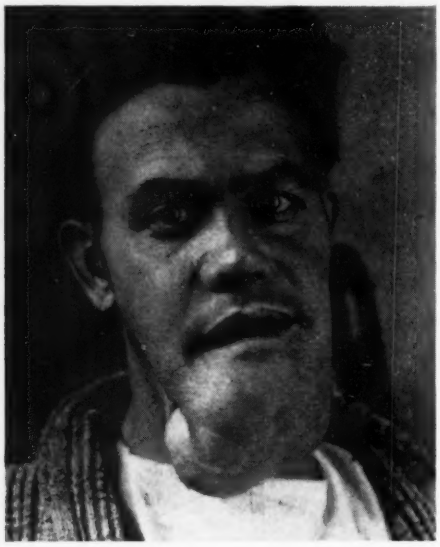

Fig. 1.—Photograph of the patient in 1930, revealing the large lower jaw.

The large jaw gave him no discomfort in early life, but progressively grew larger as he grew older. In April, 1925, he started having pain and swelling of the right side of the lower jaw, and began to expectorate pus and blood. This train of symptoms continued until August of the same year, when he entered another hospital where some dead bone was removed from the jaw, after which he improved. A salivary fistula remained on the right side.

He had no further trouble until five months before admission, when he began having pain and swelling of the left lower jaw, with expectoration of pus and blood. The symptoms continued, and as the aching pain became very severe, he came to this hospital for treatment.

Physical examination revealed a large, protruding lower jaw which extended downward about 9 cm. and was 11 cm. in width (Fig. 1). There was a long, broad scar on the right side with a salivary fistula present in this region (Fig. 2). The maxillae also appeared prominent. On inspecting the inside of the mouth, the floor was seen to be lengthened forward. Many teeth were missing; those

present were dirty and carious. There were several sinuses from the infected left mandible opening through the mucous membrane. The salivary fistula could be seen on the right side. The superior maxillae were massive and protruding (Fig. 2). The frontal sinuses could be transilluminated, the maxillary could not. The left leg was two inches shorter than the right. There was a ten-inch scar on the lateral side of the left thigh, and the femur was bowed laterally and anteriorly. Physical examination revealed no other relevant abnormalities.

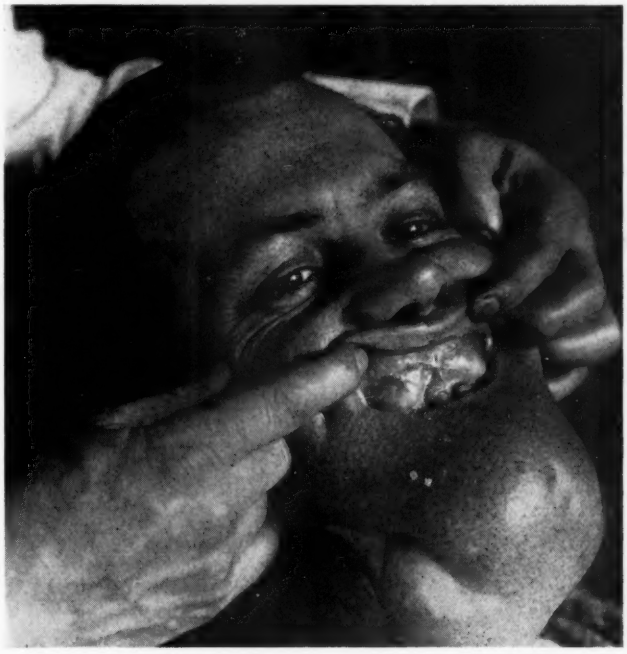

Fig. 2.—Photograph in 1930 showing massive enlargement of the superior maxillae and the opening of the buccal fistula. Note that the intermaxillary bone is apparently uninvolved. (See Fig. 7.)

X-rays revealed a large mass of osteoid tissue projecting from the lower jaw at its anterior portion. The maxillae also showed marked dense new bone formation projecting into the antra (Fig. 3). A diagnosis of leontiasis ossea was made. Roentgenograms of the calvarium (Fig. 4), shoulder girdle, pelvis, and long bones revealed no abnormalities except for the old healed fracture of the left femur which showed some deformity, and two small cystic areas in the lower end of the left radius.

Laboratory study revealed no abnormalities of the blood or urine. The blood Wassermann was negative. The blood calcium was 10.5 mg. per 100 c.c. The basal metabolic rate was plus 11.

While the patient was in the hospital, operation was performed on the left jaw at two different times, with removal of necrotic bone. Pathologic study of the tissue removed revealed only osteitis. He was discharged from the hospital Jan. 20, 1931, with the left jaw improved, and with instructions to return for a follow-up examination in several weeks.

The patient was readmitted to the hospital, April 23, 1931, having had considerable trouble with the left jaw during the previous month. Examination revealed considerable swelling of the left jaw with draining external sinuses, large sinuses opening into the mouth, and a large piece of necrotic bone presenting.

This was removed surgically. He was discharged from the hospital May 5, 1931, greatly improved.

He was not heard from again until six years later when he sent a letter to the hospital on an irrelevant subject. Following this occurrence, efforts were made to get him to return for follow-up study, but without success until June 18, 1942.

Fig. 3.—Roentgenogram in 1930 revealing the involvement of the superior maxillae and mandible.

Fig. 4.—Roentgenogram in 1930 showing no involvement at this time of the base of the skull or cervical vertebrae. Compare with Fig. 9.

During the eleven years since he was seen at this hospital, the jaw had grown progressively larger, and the salivary fistula had remained open. A considerable amount of osseous tissue had sloughed from the maxillae several years previously. He had received no treatment of the jaw in the interval except for dressings. He

Fig. 5.—Photograph in June, 1942, revealing the huge tumor of the right jaw, which was stony hard.

Fig. 6.—Lateral view taken at the same time as Fig. 5, showing ulceration and the buccal fistula in which later epidermoid carcinoma was demonstrated.

had had a third fracture of the left femur three years prior to admission, with closed reduction.

The tumor of the jaw had grown considerably larger in the past three years, with a great acceleration in growth during the past nine months. He had been able to work until then, but during the past nine months he had lost a great deal of weight and strength and had to go to bed one month previously.

Examination on admission, at the age of 39 years, revealed the patient to be anemic and malnourished, with moderate edema of the feet. There was a huge, round, solid tumor extending from the lower jaw downward, and resting on the chest (Fig. 5). This tumor measured 32 by 22 by 22 cm. and presented large superficial ulcerations on both posterolateral surfaces. On the right side near the

Fig. 7.—Photograph taken after operation, June, 1942, revealing the healing skin wound, the openings into the antra, and the persistent intermaxillary bone in which two teeth can be seen. Compare with Fig. 2.

corner of the mouth was the buccal fistula, 9 cm. in diameter, the base filled with necrotic bone and granulation, and the fistulous tract into the mouth lined with a firm tissue thought to be old granulation tissue (Fig. 6). The lower lip was pulled forward and downward, and the floor of the mouth lengthened forward. The alveolar ridge appeared to be about 6 cm. in horizontal thickness and was continuous with the tumor mass. The patient could not close his mouth. Where the maxillary processes had sloughed, there was a smooth mucosa-lined communication between the cavity of the mouth and the antra and nose (Fig. 7). The patient kept wads of tissue paper tucked in these openings. The only remaining

portion of the upper jaw was the intermaxillary process in which there were two carious teeth.

X-rays revealed a tremendous increase in the size of the sclerotic bone tumor of the mandible (Fig. 8), and some sclerotic bone involvement of the base of the skull and upper cervical vertebrae (Figs. 9 and 10). The large dense areas in the maxillae were no longer present. X-rays of the pelvis, lower spine, and long bones revealed no abnormalities except for the deformed left femur. The cystic areas in the lower end of the left radius were no longer evident. The chest roentgenogram was negative.

Laboratory study revealed a secondary anemia. The hemoglobin was 27 per cent (Dare), the red cell count 2,240,000, and the white cell count 37,000. The urine was negative. The blood calcium was 7.1 mg. per 100 c.c., the blood phosphorus 2.8 mg. per 100 c.c., and the blood phosphatase 7 Bodansky units. The patient was given three whole blood transfusions, following which the hemoglobin was 71 per cent (Dare), and the red count 3,430,000.

Fig. 8.—Roentgenogram showing the sclerotic bone tumor of the lower jaw. Note absence of dense masses in superior maxillae seen in Figs. 3 and 4.

June 25, 1942, under pentothal sodium anesthesia, the tumor was resected with considerable difficulty. Skin flaps were fashioned anteriorly and posteriorly, the tumor freed from the soft tissue, the alveolus delimited by mucosal incisions, and the horizontal ramus of the mandible cut across on both sides, freeing the tumor. The distortion was great, and the structures in the floor of the mouth could not be identified. The attachments of the sublingual group of muscles were cut, so that the hyoid bone was left with little muscular support. A good deal of blood was lost during the rapid operative procedure, and the patient's respirations were irregular due to plugging of the airway with blood and distortion of the trachea from the tug of the tumor during manipulation. A blood transfusion

Fig. 9.—Postoperative roentgenogram revealing remaining disease in the mandible and sclerosis involving the base of the skull and the upper cervical vertebrae.

Fig. 10.—Anteroposterior postoperative roentgenogram to compare with Fig. 9.

was given during the latter part of the procedure. A tracheotomy was performed as soon as the tumor mass was removed. Breathing then became smooth, and the patient's condition good.

The floor of the mouth was closed by uniting the incision at the base of the tongue to the incision in the sulcus of the lower lip with a continuous catgut suture. The exposed bulbous ends of the mandible were rongeured away. The defects in the muscles above the hyoid were closed with catgut. After this the skin flaps were trimmed for a rough, loose fit. The edges were tacked together with widely spaced fine silk sutures over two strips of petrolatum gauze. A biopsy was taken from the indurated tissue near the buccal fistula.

Fig. 11.—Photograph of the specimen from the superior-anterior aspect. Just lateral to *X* and *Y* respectively, the two cut ends of the mandible are seen with the enormously broadened alveolar process covered with mucosa stretching between them from *X* to *Y*. Below is the surface from which the anterior skin flap was removed; the cut edge of the remaining skin can just be seen at the lower border of the specimen. Epidermoid carcinoma was found in the tissue to the left of *X*.

Pathologic examination revealed a huge, ovoid, stony, hard tumor measuring 33 by 21 cm. and weighing 6,035 Gm. The tumor was covered mostly by skin except for the anterior aspect which represented the field of surgical operation (Fig. 11). On this surface were seen the cut rami and the intervening segment of the mandible from which the tumor obviously arose. A fistula partially lined with epithelium connected the superior aspect of the specimen with a large irregular area of ulceration about 8 cm. in diameter situated on the right anterolateral aspect of the tumor just below the line of excision. The lining of the distal 2 or 3 cm. of this tract as well as the contiguous margin of ulcerated skin was much thickened and roughened and covered with purulent exudate which escaped abundantly from the surface of necrotic bone lying in the base of the large ulcer. The posterior aspect of the tumor, which had long rested upon the anterior chest wall, showed an irregular area of skin necrosis, obviously the result of pressure.

On section the entire tumor was found to be composed of calcified material resembling cancellous bone with abundant pearly gray fibrous stroma. Many large areas of necrosis were seen. There was no evidence of the formation of bone marrow, such as might be expected in a benign proliferation of cancellous bone. The entire mass had the appearance of a benign bone tumor in which much necrosis had occurred.

The microscopic examination of sections from many parts of the tumor showed various stages of the process by which this tumor was apparently formed. They may be listed as follows: (1) Well-formed areas of osteoid tissue without calcium surrounded by marginal osteoblasts imbedded in very abundant and cellular fibrous stroma (Fig. 12); (2) calcification of such areas to form cancellous bone with reduction in size and number of osteoblasts and with an increase of collagen in the surrounding stroma which at this stage appears less cellular (Fig. 12); (3) increase

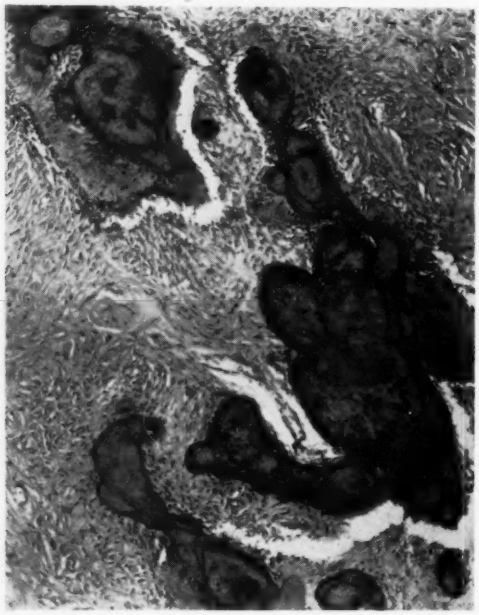

Fig. 12.—Photomicrograph showing osteoid areas both uncalcified and calcified. The diminution of the number of osteoblasts about the calcified areas should be noted.

in the amount of stroma which appears to compress and distort the lamellae of cancellous bone. The latter in this stage were denser and showed no osteoblasts (Fig. 13); (4) necrosis of bone with granular masses of calcium and small fragments of necrotic bone embedded in dense fibrous stroma; (5) necrosis of large areas which are infiltrated with leucocytes.

Sections of the buccal fistula and the adjacent ulceration reveal epidermoid carcinoma, grade 1 (Fig. 14).

Diagnosis.—Osteitis fibrosa of the mandible (leontiasis ossea) with buccal fistula showing epidermoid carcinoma, grade 1.*

The patient did well postoperatively. He was fed through an inlying gastric tube at first, but this and the tracheotomy tube were removed after ten days, and he was able to take liquids and later soft diet. The wound gradually healed

*We are indebted to Dr. J. R. Cash, Professor of Pathology, for the pathologic study.

with some puckering of the line of union and of the flap (Fig. 15). The lips could not be closed, probably from prolonged stretching of the musculature of the lower lip. He was discharged, July 15, 1942, with instructions to return in six weeks.

The patient returned Aug. 27, 1942, having gained considerable weight and strength. There were fungating recurrences of the epidermoid carcinoma, proved by biopsy, on the right side of the jaw and in the midline where a small ulcer

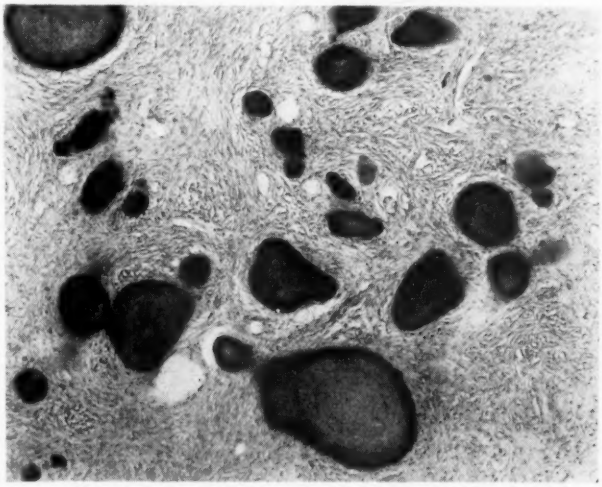

Fig. 13.—Photomicrograph showing an apparently later stage than Fig. 12. Note the condensation of the bone trabeculae, the complete disappearance of osteoblasts, and the increased relatively acellular stroma.

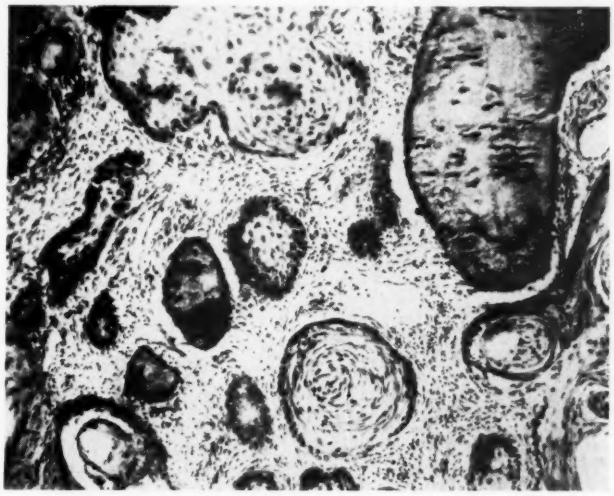

Fig. 14.—Photomicrograph showing areas of epidermoid carcinoma scattered among relatively mature bony trabeculae which may represent part of the original mandible.

was present (Fig. 16). An attempt at surgical excision was abandoned when the tumor was found to extend into the tissues beneath the tongue. The patient had taken the anesthetic poorly, and a second tracheotomy became necessary. The tumor was then treated with x-ray, being given a total of 4,000 r. through two lateral portals at 200 kilovolts. He was discharged again Sept. 28, 1942.

Fig. 15.—Postoperative photograph, July, 1942, showing puckering of the flap and inability to elevate the lower lip. The tracheotomy wound is healed.

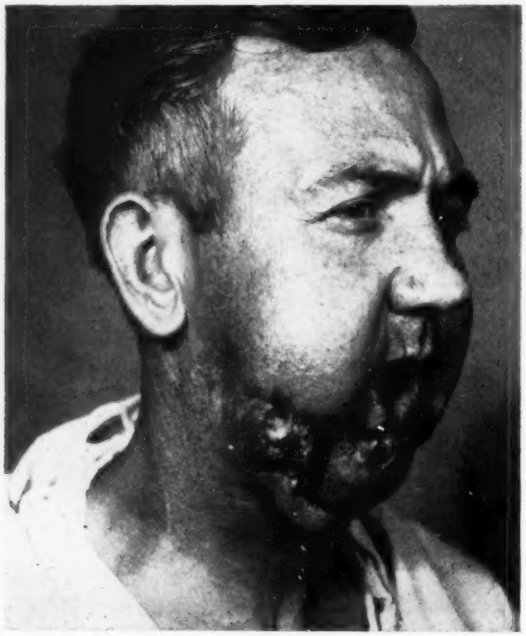

Fig. 16.—Photograph taken August, 1942, showing the fungating epidermoid carcinoma.

The patient was seen Nov. 12, 1942, complaining of pain in the right jaw. The visible epidermoid tumor had almost completely regressed, and the involved tissues had softened (Fig. 17). There was a large sequestrum projecting into the mouth from the right horizontal ramus, which was removed. Pathologic study revealed epidermoid carcinoma invading the bone.

He returned for the last time Dec. 17, 1942, still complaining of pain in the right jaw. Examination revealed a firm fungating lesion near the stump of the right mandible. There was also a large, hard metastatic node in the right supraclavicular space. His weight had remained stationary. No treatment was given.

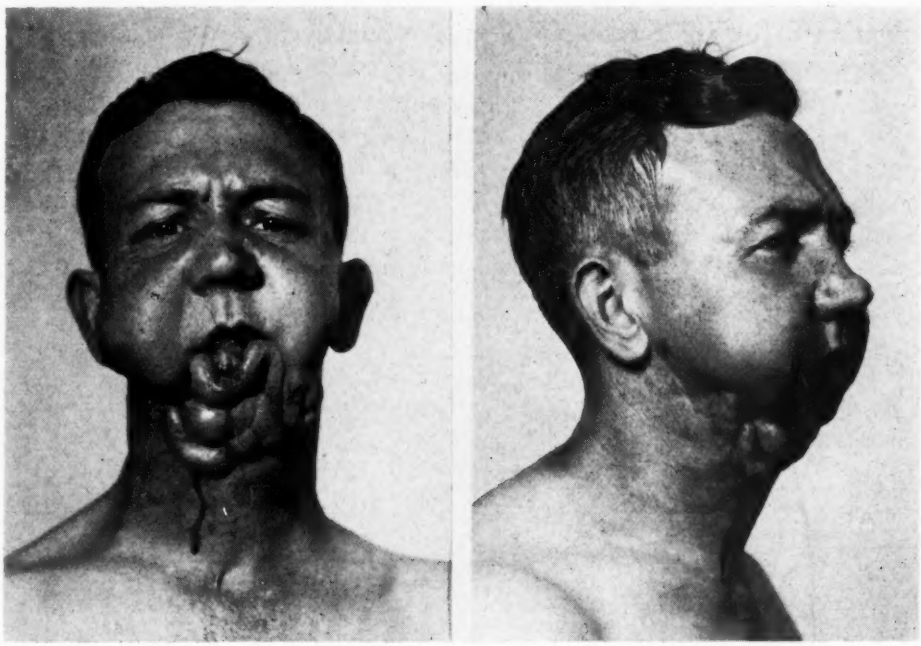

Fig. 17.—Photograph taken November, 1942, showing the regression in the visible epidermoid carcinoma and the marked increase of puckering of the flap, possibly due to infiltrating tumor.

The patient was admitted to another hospital in January, 1943, suffering from profuse hemorrhage from the ulcerating epithelioma. He succumbed to a second hemorrhage in March, 1943, in a distant locality. No post-mortem examination was performed.

DISCUSSION

This case of leontiasis ossea, originating in youth, seems to belong to Group I of Monti's classification.[6] Although it adds nothing to our knowledge of the etiology of the disease, it presents several aspects of interest.

In the first place, the spontaneous sloughing of the dense maxillary lesions with apparent local cure is unusual. This was presumably the result of infection similar to the process in the mandible for which he was first treated at this hospital. The arrest of the disease in this area may have protected the patient from the effects of craniostenosis. It raises the question as to whether radical excision of the diseased areas in

an early stage might modify the gradual spread of the lesion. Coppo is stated[4] to have reported a case of resection of the right superior maxilla for leontiasis ossea. The present case is also interesting on account of the enormous size of the jaw lesion which in itself caused complete disability. One of the earlier cases[3 (Case 17)] shows a tumor of the jaw comparable to the present example. In the third place, the case illustrates the spread of the process into the upper cervical vertebrae, a phenomenon reported previously.[7] The limitation of the process to that portion of a bone arising in a single anlage as described by Mayer[5] is illustrated by the escape of the intermaxillary process although the superior maxilla on each side was involved to a marked degree.

Finally, the complicating epidermoid carcinoma which determined the outcome of the case is unique. This neoplasm is unquestionably of the same nature as Marjolin's ulcer occurring in chronic ulcer of the skin and in chronic sinuses. The incidence of epidermoid carcinoma in a buccal fistula has not been made the object of a search of the literature, but it must be excessively rare.

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A CASE OF A SPONTANEOUS GASTROJEJUNAL FISTULA EIGHT YEARS AFTER AN OPERATIVE GASTROJEJUNOSTOMY

LOUIS RENE KAUFMAN, M.D., F.A.C.S.,* AND HELEN I. HEIMAN, M.D.,†
NEW YORK, N. Y.

(From the Surgical Service, New York Medical College and Flower and Fifth Avenue Hospital, and the Metropolitan Hospital)

UNUSUAL problem cases are frequently encountered in a large city hospital service, and their reporting becomes an obligation. We are reporting a single case of unusual interest which we have not encountered at any other instance either in practice or in a survey of the literature. The case is that of a new spontaneous gastrojejunal fistula, following a posterior gastrojejunostomy performed eight years previously.

CASE REPORT.—C. McL. was admitted to the Metropolitan Hospital April 1, 1943. The patient was a 70-year-old white woman, complaining of dysphagia, vomiting, and loss of ten pounds for the previous three months. She had had symptoms of dyspepsia and nausea since youth. Eight years previously, a posterior gastrojejunostomy had been performed for duodenal ulcer, and the patient was then comfortable and symptom free for the first time in her life until the onset of this illness three months prior to admission.

Physical examination showed a chronically ill, white woman with marked pallor and evidence of weight loss. There was a right rectus scar and medial to this very slight epigastric tenderness, but no abdominal masses were noted. Examination was, otherwise, negative.

X-ray and fluoroscopy revealed a normal esophagus, but the stomach was enlarged, and there was a five-hour residue; the gastrojejunal stoma was not visualized. Several gastric analyses showed high total acid up to 75, high free acid up to 48, high combined acid of 27, with occult blood in most specimens.

Gastroscopy revealed a patchy, superficial gastritis with some adherent exudate and punctate hemorrhages. The rugae were atrophic. There was a pseudovalve of the stoma, but the opening was more than adequate, and the jejunum was easily and clearly seen. The many jejunal peristaltic waves indicated possible obstruction below the stoma. There were 2,000 c.c. of gastric residue.

The patient was treated with gastric lavages, numerous transfusions, liver extract, and iron. Hemoglobin increased from 52 per cent to 70 per cent, and there was marked improvement both subjectively and objectively. After three weeks, exploratory laparotomy was undertaken with the view to doing a subtotal gastrectomy if this were possible.

At operation, the stomach was found greatly dilated. Easily separable adhesions bound the anterior surface to the round ligament and parietal peritoneum. About where one would expect the gastrojejunostomy to be found, an anastomosis was visualized, and sharp angulation of both proximal and distal jejunal loops noted. The apparent stoma was located in the transverse mesocolon just at the edge of the

*Director of Surgery, Metropolitan Hospital, Professor of Surgery.
†Resident in Surgery, Metropolitan Hospital.
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colon, in the midst of a large inflammatory mass, about 11 by 4 by 7 cm. The anastomosis was taken down by dissecting the mass, first from the colon and mesocolon, and then from the stomach. The part of the jejunum attached to the mass was resected, and an end-to-end anastomosis of the jejunum was done.

The gastric wall surrounding the site of the anastomosis was inflamed and thickened for a radius of about 2 cm. That portion of the wall was resected. A finger was inserted into the stomach through this opening and exploration revealed that distal to it was a wide orifice into what was thought to be the duodenum. (However, autopsy later revealed that this orifice was the original gastrojejunostomy; the "anastomosis" which was let down was the spontaneous inflammatory gastrojejunostomy.) The defect of the stomach wall was completely closed, and the rent in the mesocolon was sutured. While the stomach was open, a Levin tube was guided well into the small intestine.

Postoperative Course.—The patient was given oxygen and several transfusions. The Levin tube was aspirated at intervals and large quantities of dark brown fluid were removed. Twenty-four hours postoperatively, the patient suddenly went into shock and expired.

Autopsy Report.—The mucosa of the stomach presented some reddening and no ulceration. Rugae were not prominent. The region of the pylorus showed complete obstruction with an area of white scar tissue which occluded the opening into the duodenum. An apparently well-functioning anastomosis between the jejunum and posterior gastric surface was present. Proximal to this anastomosis was a sutured defect of the posterior gastric wall. In the descending loop of the jejunum, distal to the gastrojejunostomy, was an end-to-end anastomosis surrounded by a certain amount of edema. The mesocolon was scarred, and the transverse colon was thickened.

DISCUSSION

At operation, what was thought to be the old gastrojejunostomy with a marginal ulcer was resected. Since it was felt that there was a patent pylorus and duodenum, no new jejunostomy was performed.

At autopsy, it was shown that what we had thought to be a patent pylorus was a well-functioning, eight-year-old gastrojejunostomy. The stoma was located almost in the pyloric antrum at the greater curvature with a short loop of jejunum about 14 cm. from the ligament of Treitz. The area resected was a spontaneous gastrojejunostomy, about 8 cm. proximal to the artificial one (proximal in the stomach, but distal in the jejunum; see Fig. 1). The pylorus had apparently not been patent for the past eight years.

The most frequently discussed complication following gastrojejunostomy is gastrojejunal ulcer. Fistulas, when present, generally involve the colon. Lahey and Jordan,[1] in analyzing these fistulas, do not mention the formation of a spontaneous communication between the stomach and jejunum, the simple gastrojejunal type, but discuss only gastrocolic, jejunocolic, and gastrojejunocolic fistulas. The reported incidence of ulceration has varied from 3 per cent to 34 per cent.[2, 3] The site is usually at the anastomosis or in the efferent jejunal loop, 1 to 10 cm. distal to the stoma. Only rarely is the afferent loop affected. It is generally accepted that ulcers are produced more easily in those sites farther away from the segment which has adapted itself to receive acids. Operative technique has little bearing on the production of

ulcers opposite or some distance from the stoma,[4] but, as in our case, the high acid is obviously an important factor in causing the recurrent ulcer.

There is a higher incidence of jejunal ulcer in cases in which the pylorus is closed off. According to Alvarez,[5] "Anything that interferes with the passage of duodenal contents over the jejunal mucosa around the stoma is likely to leave this region unprotected from the corrosive effects of gastric juice and, therefore, subject to ulceration. Closure of the pylorus probably interferes with the maintenance of a good downward current in the duodenum, and the absence of food and gastric juice in the duodenum lessens the outflow of the protective bile and pancreatic juice." This is confirmed by Lahey,[6] who feels that pyloric obstruction is a predisposing factor for gastrojejunal ulcer since the highly acid gastric contents are dumped into the jejunum and cannot mix with the regurgitant alkaline contents.

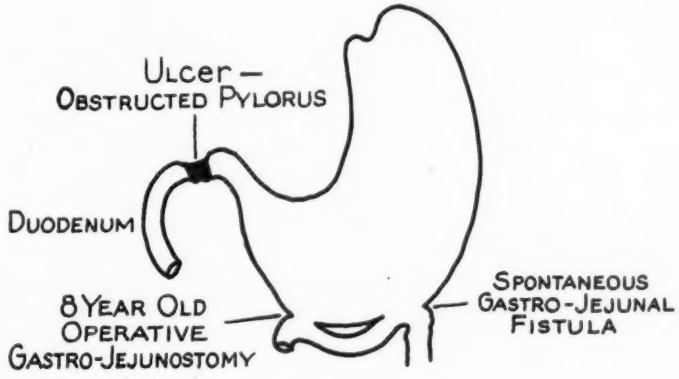

Fig. 1.

Most cases of gastrojejunal ulcer show a clinical course similar to that in peptic ulcer. Such symptomatology was absent in our patient who had been comfortable for eight years and began to complain only three months previously when signs of obstruction appeared. Hoag and Saunders[7] list the causes of obstruction following gastrojejunostomy in the following manner:

1. Improperly placed stoma
2. A stoma so small or narrow of attachment that it produces acute angulation of the jejunum
3. A proximal loop of excess length or so short as to obstruct with changing position of the stomach
4. A rigid and short mesocolon which fails to stretch on filling of the stoma
5. Inadequate fixation of the stoma to the mesocolon and internal hernia
6. Adhesions about the stoma
7. Pressure of the middle colic artery

8. Marginal or jejunal ulcers at or near the stoma
9. Adhesions distal to the anastomosis
10. Hypoproteinemia

Only the last three causes, 8, 9, and 10, were present in our case.

In view of the marked gastritis in this case, the question has been raised as to whether the spontaneous gastrojejunal fistula may have followed a perforated gastric ulcer. This is an unlikely sequence of events. Such an ulcer on the posterior stomach wall is not usual, although one was reported by Edwards[8] on the lesser curvature. It is more probable that the gastritis was secondary to the obstruction.

The failure of the gastroscopic examination to visualize the secondary opening bears mention, particularly in view of the accurate description of the stoma with the peristaltic jejunal waves indicating obstruction. The patchy exudate on the mucosa probably obscured the other opening.

In the evaluation of the pathology present in this case, one may assume two hypotheses to explain the origin of the new spontaneous gastrojejunostomy. The record indicates that eight years after the original gastrojejunostomy the patient developed an acute condition at least suggestive of an ulcer. This ulcer may have originated in the greater curvature of the stomach as a new gastric ulcer—an unlikely occurrence as noted. On the other hand, the ulcer may have developed as a jejunal ulcer, about 8 cm. distal to the original gastrojejunostomy in a location where the impact of the acid chyme would be most likely to produce ulceration of the jejunal mucosa. As the ulceration progressed to and through the serosa, inflammatory reaction might readily fix this distal segment of the original loop to the greater curvature as well as to the gastrocolic omentum since it was in close proximity to both. Further progression of the lesion might, therefore, readily result in perforation with a spontaneous gastrojejunal fistula. The marked inflammatory reaction which we noted at the time of operation lends further support to this hypothesis.

SUMMARY

A case is presented of a spontaneous gastrojejunal fistula occurring eight years after a posterior gastrojejunostomy and causing obstruction. Gastrojejunal ulcer with its complications is briefly discussed.

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PANTOPAQUE

Notes on Absorption Following Myelography

Captain George M. Wyatt, and Lieutenant Colonel Roy G. Spurling
Medical Corps, Army of the United States
(From the Sections of Roentgenology and Neurosurgery, Walter Reed General Hospital, Washington, D. C.)

PANTOPAQUE has replaced Lipiodol and the gases as the contrast medium for myelography in the Army Medical Corps. The chief reason for the preference to lipiodol is that Pantopaque is absorbed instead of remaining as a persistent foreign substance in the subarachnoid space.[1-3] Experience has shown it to be nontoxic and no more irritating than lipiodol, and its sharp radiographic contrast and consequent clear delineation of pathologic anatomy affords a definite superiority over the gases as does lipiodol. In contrast to lipiodol, pantopaque is more fluid than viscous and therefore fills out the smaller spaces such as the dural nerve sheaths. It also is more easily removed following examination.

The chief advantage of pantopaque, however, lies in its absorbability and it is the purpose of this paper to discuss this absorption as observed roentgenologically.

Observations at the Walter Reed General Hospital at intervals of a few weeks or months following injection of pantopaque suggested that absorption might not be so rapid in all patients as it was previously thought to be.[1-3] Accordingly, follow-up x-ray pictures were obtained for six patients in whom the removal of pantopaque had been incomplete. These roentgenograms included the skull and entire spine and sacrum to exclude the possibility of migration of the contrast material. The patients were selected from the first group in which pantopaque was used at the Walter Reed General Hospital, the sole bases of selection being incomplete removal and availability for follow-up study. All of these patients had ruptured intervertebral discs removed surgically but in no instance was the dura entered or any attempt at removal of the residual pantopaque made during the operation.

Amounts of residual pantopaque were estimated on the basis of the size and number of the collections shown on the x-ray pictures. Obviously such estimation is crude and the figures arrived at will vary with the individual observer. There was, however, no doubt that the material was being absorbed at a significant rate of speed (Figs. 1 and 2).

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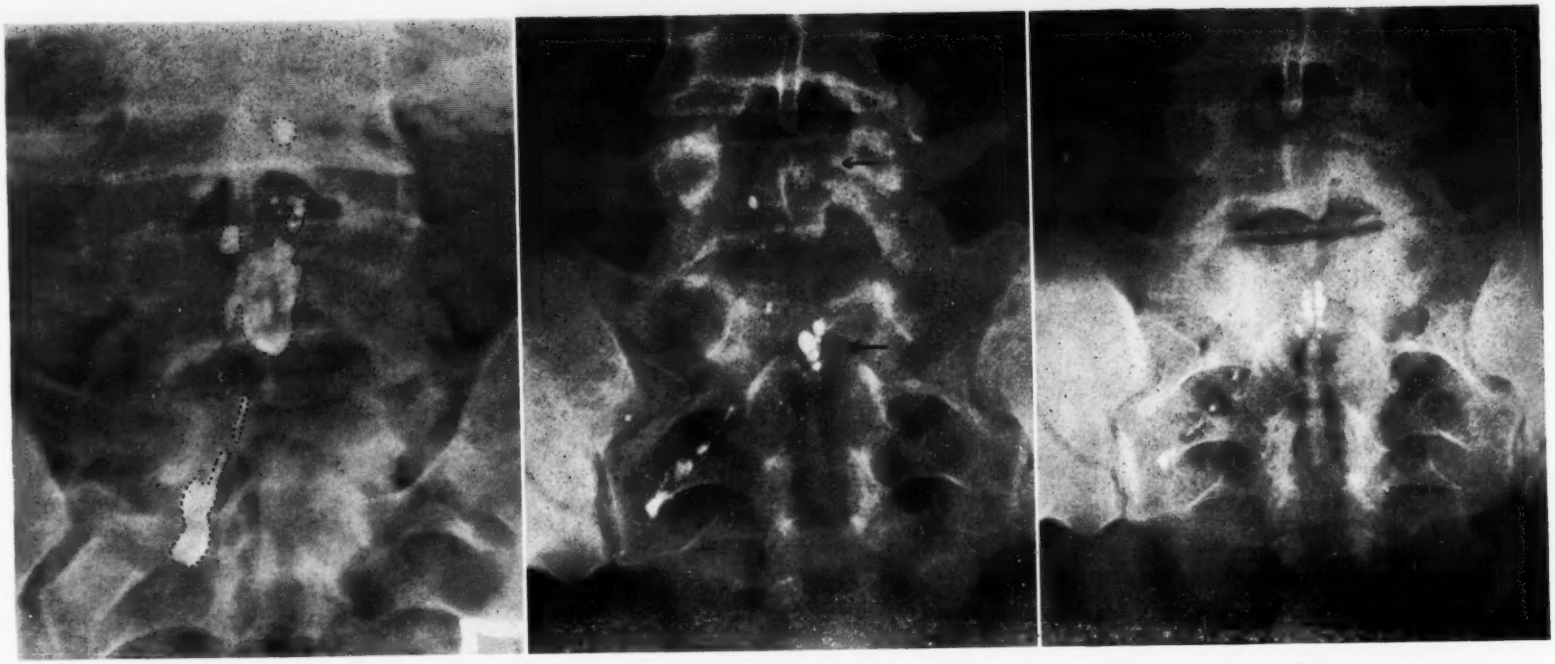
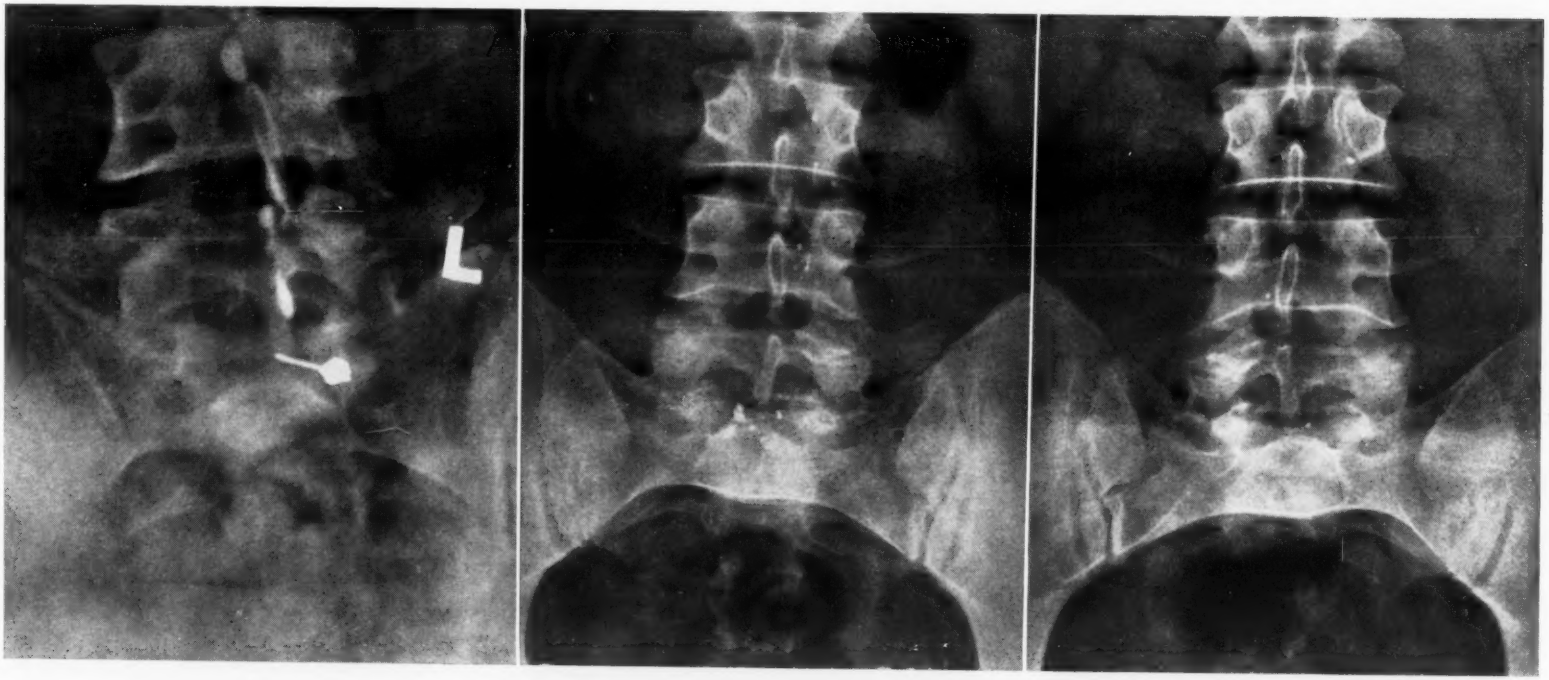


A. *B.* *C.*

Fig. 1 (Case 6).—*A*, (Retouched) Approximately 1.5 c.c. of pantopaque remains in the subarachnoid and subdural spaces and along a nerve sheath.

B, X-ray picture 2½ months later shows about 80 per cent absorption. It also represents the only instance in which iodine was seen to be absorbed from the compound. (Upper arrow indicates globules of the same size but less density than those indicated by lower arrow.)

C, X-ray picture taken 12½ months after examination shows about 90 per cent absorption both in the meninges and along the nerve sheath. The patient was symptom-free.



A. *B.* *C.*

Fig. 2 (Case 3).—*A*, Approximately 0.5 c.c. of pantopaque remains in the subarachnoid space.
B, Roentgenogram 1½ months later shows about 75 per cent absorption.
C, Roentgenogram 14 months after examination shows about 95 per cent absorption. The droplets are fixed in the same position as in *B*.

Estimates of residual amounts and percentage absorption were arrived at separately by us. An approximate average of these estimates is presented in Table I.

TABLE I

ESTIMATED ABSORPTION OF RESIDUAL PANTOPAQUE

CASE NO.	AMOUNT INJECTED AT EXAMINATION (C.C.)	AMOUNT NOT REMOVED AT EXAMINATION (C.C.)	TIME INTERVAL AFTER EXAMINATION (MO.)	PERCENTAGE ABSORPTION
1	3.5	0.1	9	70
2	3.5	0.2	1½	None perceptible
			6½	50
			15	80
3	3.5	0.5	1½	75
			14	95
4	3.5	1.0	13	90
5	3.5	1.5	15	95
6	3.5	1.5	2½	80
			12½	90

As judged by the x-ray shadows there was a definite decrease in the amount of residual pantopaque in all cases. The size and density of the remaining droplets showed that this decrease was due to absorption of the entire compounds rather than of iodine from the compound. In several instances minute residual droplets were as opaque to the x-ray as larger droplets seen immediately following incomplete removal. If the decrease in density seen by x-ray were due to the absorption of iodine from the compound rather than absorption of the total mass, the remaining small collections would lose their radiopacity. In only one instance was a relative decrease in density of residual droplets observed (Fig. 1). The general tendency was toward a progressive increase in density with decrease in the total amount remaining.

Absorption was usually most rapid during the first few months following examination (Figs. 1 and 2). Following this initial absorption, the small remaining droplets were absorbed at a relatively slower rate. Slow absorption of minute amounts was also demonstrated by Case 6 (Table I and Fig. 3). In no instance was absorption complete during the period of observation, although the continued change in all instances warrants the assumption that complete absorption will eventually take place.*

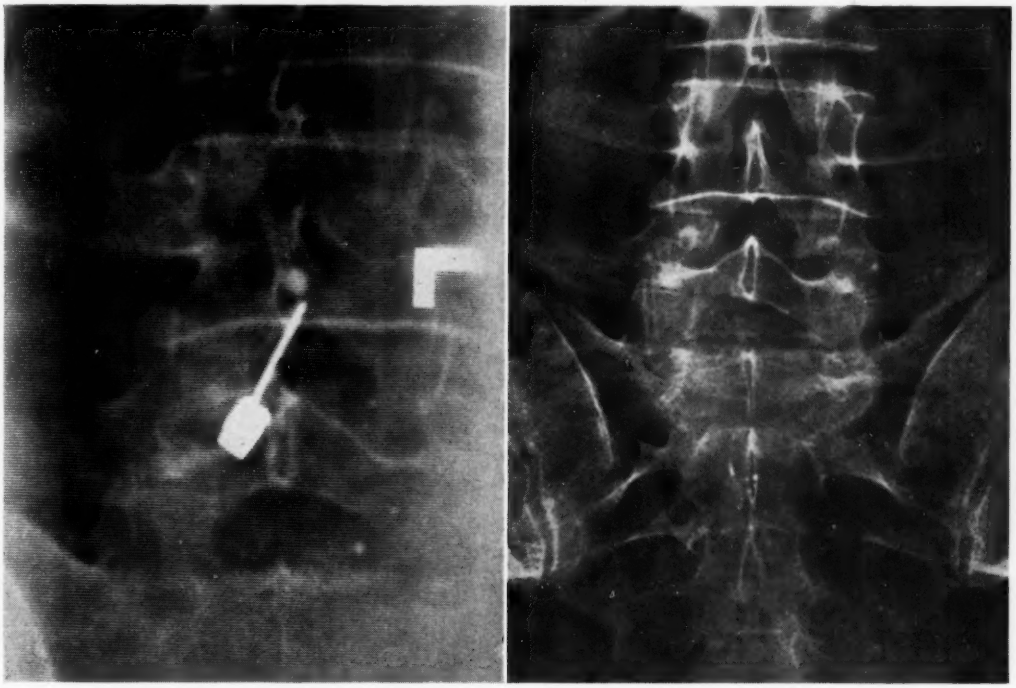
The variations in the rate of absorption and in the density of the residual droplets may be due to the nature of the contrast medium which is a mixture of isomers. Some of the isomers may vary slightly in absorbability.[1, 4]

Another factor which may be responsible for the faster absorption of larger amounts of pantopaque is the emulsifying action of body motion on the larger collection of 0.5 c.c. upward. Such emulsifying action is best observed during cervical myelography during which the contrast medium flows the entire length of the spine (Fig. 3). The surface area

*Since this article was submitted for publication, one of us (G. M. W.) has observed complete absorption of approximately ½ c.c. of pantopaque in a period of eleven months.

presented by the small particles is much greater in relation to the total mass considered as a single spheroid than is the surface area presented by a few small droplets. When only a few small droplets remain the tendency is toward coalescence rather than breaking up with body motion.

As previously stated, the entire subarachnoid space was surveyed. The contrast medium was observed to flow as high as the first lumbar vertebra but none of the roentgenograms revealed any pantopaque in the skull, cervical spine, or thoracic spine. The only explanation for the lack of migration is that the patients did not assume the head-down



A. *B.*

Fig. 3 (Case 1).—*A*, A minute quantity (estimated as 0.1 c.c.) of pantopaque remains in the subarachnoid space.

B, Roentgenogram 9 months later shows only about 70 per cent absorption. The small remaining droplets are relatively as dense or denser than the original compound.

position during the first few weeks following examination. After a month or two, the material becomes fixed in position. This fixation indicates some tissue reaction to residual pantopaque. None of the patients, however, had any symptoms referable to the residual material, even though in one instance some pantopaque had been injected subdurally and remained in a nerve sheath (Fig. 2).

CONCLUSIONS

1. Pantopaque is absorbed from the subarachnoid and subdural spaces of the human body.

2. The most rapid absorption occurred during the first few months following injection.

3. Although absorption was not complete during the periods of observation, the continued absorption in all instances warrants the assumption that complete absorption will eventually take place.

4. No toxic reactions were observed.

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Editorial

The Obligations of an Internist to a General Surgeon

AN INTERNIST has been defined as a man who is totally unable to answer either yes or no to any question. The definition was made in jest but there is much truth in it. If there is such a thing as a typical internist, he is a sedentary individual, curious, skeptical, reflective. He is accustomed to look at the patient as a unit rather than as a collection of separate organs and, if he has had the fundamental scientific training he should have had, he is eager to distinguish between a fact and someone's opinion. Although often powerless to suggest an alternative procedure, he regards every operation as an exercise in violent therapeutics and a confession of failure to cure. He is, however, humble before the complexities of modern surgical technique. His fees are not such as to command general admiration.

The surgeon, on the other hand, is a man of action. He lives in an exhilarating world of knives, blood, and groans. His tempo is of necessity rapid. He is inclined to look at his less kinetic colleague with an air of puzzled condescension but may, in a relaxed moment, admit that the medical man is occasionally able to assist uncomfortable dowagers in the selection of a cathartic. Accustomed to legerdemain and quick results, he is apt to regard the diagnosis and treatment of a headache, for example, as a trivial matter, forgetting that the internist may require hours of probing before discovering that what the patient needs is not a new pair of glasses but a different mother-in-law. The surgeon and the internist are workers in the same vineyard, but their points of view are inevitably different.

Of those patients who come to any clinic for help there is a certain small percentage who present definite and well-demarcated problems—a broken arm, a decompensated heart, a gravid uterus, for example. Of these the internist will claim his share and do what he can. Over and above these, however, is a larger number with ill-defined complaints who tax the resources of the entire staff. These are the ones who are commonly x-rayed from head to toe, whose fluids and excrements are examined with great skill, into whose every orifice electric lights are inserted—to no avail! The standard reaction on the part of the medical attendant then is that of anger. The patient is automatically regarded as an imposter who has no right to his symptoms and his visit to the clinic is looked upon as a nuisance and an intrusion. Actually, of course, these are perhaps the sickest people we see. It may be argued that they are merely suffering from such elemental emotions as grief, frustration,

inadequacy, fear, or sorrow, that their problems are therefore nonmedical, and that the clinic is not required to help them. If this is so, we are amateur physicians indeed.

W. R. Houston has frequently and eloquently pointed out that sickness of any sort carries with it a curious and sometimes irresistible demand for action. There is nothing to which a sick man will not submit himself—he is gladly purged, puked, bled, transfused, sweated, infused, cut, frozen, heated, and shocked and he will swallow literally anything. It is seldom that the consequences of these actions are considered, for it is action itself that is demanded. Even the most normal of us howl and gyrate when thrust suddenly into pain; these actions serve no useful purpose whatever, but somehow they seem to bring relief.

And so these people come to us in their distress demanding both action and relief. This demand comes not only from the patient but from the family as well. One can never enter a sickroom without being immediately aware of immense forces at work. The urge to violence is often so compelling that it requires great courage to follow the wiser course and do nothing. Certainly it is a commonplace experience for patients to complain that we have found nothing for which to operate upon them, and it is no consolation to these people to be told that their roentgenograms and blood tests are negative. It is another curious fact that no one minds being told that he has something wrong with one or more of his organs, but he bitterly resents the implication that the trouble lies within himself. A heart that is failing a little, a sluggish liver, a pair of weak lungs—these are cherished and respected ailments—but a personality defect is accepted with the greatest reluctance.

In dealing, as it must, with individuals whose primary difficulty is emotional, a clinic finds itself in a peculiarly dangerous situation because a certain percentage of these patients will inevitably present some physical abnormality which, in a more stable host, would be a legitimate surgical target. The diagnosis of anxiety state, chronic reactive depression, or conversion hysteria is not made by exclusion, however, and it would be a major error to assume that an elderly housewife could not have a psychogenic backache and a fibroid tumor as well. The surgeon often accuses the internist of complacency and ignorance when he chooses to ignore a uterus which is not quite perpendicular, or a solitary gallstone, or a pair of tonsils from which a fluid of unknown composition can be expressed. There are certain people, however, who demand violence; the surgeon enjoys removing organs and one function of the internist is to see that these two never meet.

—*Thomas Findley, M.D.*
New Orleans, La.

Recent Advances in Surgery

Conducted by Alfred Blalock, M.D.

AN ANALYSIS OF THE MORE IMPORTANT ORTHOPEDIC INFORMATION

Presented at
The Twelve Regional Fracture Orthopedic Conferences of the Army Air Forces
Sponsored by
The Air Surgeon
Oct. 18 to Nov. 27, 1943

Lieutenant Colonel Alfred R. Shands, Jr.,* Medical Corps,
Army of the United States

INTRODUCTION

DURING the fall of 1943 the air surgeon, through his Medical Services Division, conducted twelve two-day regional fracture orthopedic conferences within the limits of the continental United States, at which 196 papers were presented. As orthopedic consultant to the Army Air Forces, I attended all conferences and made written notes on the information presented in both the papers and the discussions. The purpose of this publication is to analyze the more important orthopedic information presented at these meetings and to bring this to the attention of medical officers and physicians responsible for the treatment of orthopedic conditions and fractures in the Armed Forces and in civil practice. One hundred nineteen papers were submitted after the conferences. These have been carefully reviewed for this publication. Many of them will be published later.

In analyzing this considerable volume of data and selecting material for presentation, I have laid especial emphasis upon the following: (1) new and original ideas appearing worthy of consideration, (2) old ideas on pertinent subjects presented in an original and instructive manner, (3) opinions on controversial subjects, and (4) statistics on incidence, operations, and end results. An attempt has been made to report accurately and to interpret clearly this information as derived from both the papers and the discussions. I have interpolated comments where they seem indicated but have tried not to confuse the reader with too much of my own opinion.

In this analysis the names of medical officers and physicians from whom the information has come, with the exception of those of a few

*Consultant in Orthopedic Surgery to the Army Air Forces and Chief of the Surgical Branch of the Professional Division, office of the Air Surgeon.

prominent civilian physicians, have purposely been omitted; upon request, however, I will supply the source of all information.

The papers on Convalescent Rehabilitation, Physical Therapy, Burns, Cranial Injuries and Anesthesia are not included in this analysis. There were many excellent contributions in this group.

An excellent paper on Bone Metabolism was presented, in which the delay in fracture healing at high altitudes was described. This paper, which contains many entirely new ideas, has not been included in the present analysis because it should be published first by its authors as an independent contribution. Also, such presentations as Historical Notes on Military Orthopedics and Psychiatry in Orthopedic Surgery will be published as complete papers.

Before each meeting, a list of suggested titles and speakers was sent to the orthopedic surgeon who was to serve as host and he was directed to organize his own program. The twelve final programs included 196 papers; their subjects, divided into suggested and miscellaneous titles, were as follows:

ANALYSIS OF THE SUBJECTS OF THE SCIENTIFIC REPORTS

A. Suggested Titles

	NO. OF PAPERS
1. Splinting and Transportation of Fractures	12
2. Fractures and Dislocations of Hand and Wrist	12
3. Fractures and Dislocations of Forearm, Elbow, and Arm	11
4. Fractures and Dislocations of Shoulder	12
5. Fractures and Dislocations of Hip, Thigh, and Knee	13
6. Fractures and Dislocations of Leg and Ankle	10
7. Fractures and Dislocations of Foot and Toes	12
8. Fractures and Dislocations of Spine and Pelvis	10
9. Compound Fractures	10
10. Conditions Involving the Back	11
11. Conditions Involving the Knee	11
12. Conditions Involving the Foot	12
13. Convalescent Rehabilitation	12
14. Physical Therapy	7
15. Burns	12

B. Miscellaneous Titles

16. Amputations	1
17. Anesthesia	3
18. Ankle Sprains	1
19. Aseptic Necrosis	1
20. Aviation Medicine	1
21. Bone Graft Surgery	1
22. Bone Metabolism	1
23. Casualties in Italian Prisoners of War	1
24. Cerebral Injuries and Skull Fractures	5
25. Complications of Fractures	1
26. Early Laminectomy for Spinal Cord Injuries	1
27. External Skeletal Fixation (The Stader Method)	1
28. Historical Notes on Military Orthopedics	1
29. Infections of the Hand	1
30. Intravenous Morphine	1
31. Jaw Fractures	2
32. Management of the Sick Orthopedic Patient	1
33. Orthopedic Conditions and "64" Examination for Flying	1
34. Penicillin	2
35. Protrusions of the Intervertebral Disc	1
36. Psychiatry and Orthopedic Surgery	1
Total	196

Of the 196 essayists, 128 were from the Army Air Forces, 43 from the Army Service Forces, 24 from civilian practice, and 1 from the Navy. There was an average of 16 papers per conference.

At these twelve conferences there was an average attendance of 122 officers and civilian physicians. Of the 1,460 total attendance, 1,194 were from the Army Air Forces, 145 from the Army Service Forces, 96 from civilian practice, and 25 from the Navy.

Attending the conferences were representatives of 304 Army and Navy hospitals, as follows: 228 station hospitals of the Army Air Forces, 31 general and 39 station hospitals of the Army Service Forces, and 6 hospitals of the Navy.

In conclusion to these introductory remarks, I wish to express my appreciation and thanks to those in the twelve conference hospitals who made each meeting possible; to those presenting the papers and participating in the discussions, who contributed the wealth of scientific information which forms the basis of this report; to Colonel Leonard T. Peterson of the Surgeon General's Office, and Dr. R. Beverly Raney of the Duke University School of Medicine, who have so kindly read and criticized this report; and finally to the Air Surgeon, Major General David N. W. Grant, to the Chief of the Medical Services Division of the Air Surgeon's Office, Colonel William P. Holbrook, and to those others in the Air Surgeon's Office who, by their help and advice, have added so much to the success of these meetings. It is to be hoped that the conferences were of value to those attending and that this review and analysis may be of assistance to those physicians who are treating orthopedic conditions and fractures in the Armed Forces and in civilian practice.

PART I. FRACTURES AND DISLOCATIONS ABOUT THE SHOULDER

The group of fractures and dislocations about the shoulder constitutes approximately 5 per cent of the total. A very large number of injuries of the acromioclavicular joint have been reported and also a large number of recurrent dislocations of the shoulder.

1. *The Clavicle*

The importance of accurate reduction of fractures of the clavicle was repeatedly emphasized in all conferences. It was stated that the irregular bony surfaces of a malunion make it impossible for a soldier to carry a gun or pack on his injured shoulder with comfort. One officer from a general hospital had observed twelve malunited fractures, and an officer from a station hospital had operated on two malunions. Nonunion of the clavicle is extremely rare; however, six cases were reported from one general hospital.

It was pointed out by two officers that for the extensively comminuted and displaced fracture whose reduction cannot be maintained by ambulatory splints, recumbency and lateral traction to the upper arm with

the shoulder abducted is an effective form of treatment. Four excellent results were reported with this method of treatment.

The figure-of-eight dressing, usually made of plaster, is apparently more popular than the T splint; I believe, however, that the T splint is the more effective and better dressing. The immobilization period recommended was from three to six weeks. At one conference there was a favorable discussion of the Kirk-Peterson splint for fractures of the clavicle.

(*Comment.*—Fractures of the clavicle frequently unite with malunion, but in civil practice this seldom results in disability. In the Army, however, the rough edges and bony spicules of a malunion may be a constant source of annoyance and pain, because of the rubbing of the strap of a heavy knapsack or gun. Hence, accuracy of reduction is important and every effort should be made to obtain it. Lateral traction on the upper arm in recumbency may be the treatment of choice for extensively comminuted or displaced fractures.)

2. *Sternoclavicular Dislocation*

Sternoclavicular dislocations were observed infrequently. One officer reported the insertion of short Kirschner wires through the sternum and into the clavicle to maintain reduction. A fascial repair operation for chronic dislocations was mentioned at one conference.

(*Comment.*—The use of Kirschner wires across this joint may maintain reduction but is accompanied by some risk and should be undertaken only in the exceptional case. When wires are used, every precaution should be taken to prevent their inward migration, a complication which can readily occur.)

3. *Acromioclavicular Dislocation*

Acromioclavicular dislocation was discussed frequently. The common occurrence of this injury and its generally poor end result indicate that it is a real problem. Especially is this true when the coracoclavicular ligaments are ruptured and the dislocation is complete.

In many conferences there was a discussion of the use of a plaster dressing to aid in maintaining reduction of this dislocation. The dressing was applied usually in the form of a hanging body cast. One officer recommended adding to the cast a shelf for support of the elbow and forearm, in order to prevent the upper extremity from hanging down at the shoulder. A three-inch elastic bandage, taken from a rubber bandage tourniquet, was incorporated in the cast by a second officer in such fashion that the weight of the cast acting through the bandage exerted a constant downward force on the outer end of the clavicle. One physician demonstrated a twelve-inch plaster girdle incorporating a wide cotton webbing strap over the outer end of the clavicle. Three

officers recommended that a plaster spica cast with the shoulder in 90 degrees of abduction be worn from six to nine weeks.

There were several reports of a circular dressing around the outer end of the clavicle and the olecranon, adhesive plaster or a two-inch webbing strap and buckles being used. Mention was made by one officer of 138 cases reported by Thorndike of Boston, in which the circular adhesive dressing was used with good results. Whether these dislocations were complete or incomplete was not stated.

There were three reports on immediate open operation for this dislocation with an attempt to suture the torn ligaments.

One officer was of the opinion that if after three weeks the joint was unstable, an open procedure was indicated. Two officers reported the insertion of Kirschner wires from the acromion into the clavicle to fix the joint. These wires crossed the joint line and were left in place from six to eight weeks. Three excellent results were reported. Another officer reported maintaining the reduction with a large caliber Kirschner wire or a small Steinmann pin placed through the outer end of the clavicle into the acromion but not crossing the joint line. This was supplemented by a circular adhesive dressing around the elbow and outer part of clavicle. The operation of tying the clavicle down to the coracoid process with wire or fascia lata was also recommended.

There were two reports on the Vargas operation (construction of a new coracoclavicular ligament by the use of a portion of the short head of the biceps). One officer reported seven successful results, a second officer one failure.

The Mumford operation for dislocation (excision of the outer end of the clavicle) was favorably reported at two conferences; however, at one conference a weak and painful shoulder following the operation was reported.

(*Comment.*—The evidence from these discussions of the many different methods of treatment certainly indicates that no single nonoperative or operative method is always satisfactory. From personal experience, I am of the opinion that if the dislocation is complete, indicating a total rupture of the coracoclavicular ligaments, some type of open fixation of the clavicle to the acromion, with a repair of torn ligaments when possible, is immediately indicated. My clinic has four satisfactory end results from inserting three Kirschner wires through the acromion into the clavicle across the acromioclavicular joint, care being taken to turn up the outer ends of these wires in order to prevent their inward migration. At the time of operation the torn superior acromioclavicular ligaments are repaired. The wires are left in for eight weeks.

Reports of good end results following the Vargas and Mumford operations are still too few to warrant complete approval of these operative procedures for use in military surgery.)

4. *Dislocation of the Shoulder*

a. Acute.—In all of the conferences there was considerable discussion regarding the acute dislocation. The advisability as well as the necessity of using a general anesthetic for early reduction of the dislocation was frequently discussed. Five officers stated that they were using a general anesthetic; four stated that they were not. Intravenous morphine before reduction was recommended in several conferences. One officer reported the use of a local anesthetic; he injected one ounce of 1 per cent procaine directly into the shoulder joint before reduction.

The question of the optimum maneuver for the reduction was frequently discussed. Only two officers stated that they were using the Kocher technique. Of the other methods, three were described as follows:

1. The "three sheet method," in which one sheet is applied around the chest high in the axilla for a pull across the chest, a second sheet around the forearm with the elbow flexed for a pull down on the arm, and a third sheet high on the upper arm for a pull outward from the chest wall.
2. Pulling the extremity straight out in abduction, with countertraction provided by the operator's foot against the chest wall or by an assistant who pulls on a folded sheet placed in the axilla and across the chest wall.
3. Pulling downward on the arm while an assistant pushes the head of the humerus upward into the glenoid cavity.

For primary dislocations, the time of immobilization, as well as the type of immobilization, was frequently discussed. A Velpeau dressing for ten days, followed by a sling for two to three weeks, was advised by some officers. Others advocated four to six weeks of immobilization. One consultant was of the opinion that six weeks was much too long for this immobilization. For a period of eight weeks after removal of the initial dressing, one officer was using a leather buckle brace around the upper arm and chest wall to prevent abduction of the shoulder.

Another officer aptly emphasized the necessity for asking the physical training instructors not to attempt to reduce shoulder dislocations when they occur during physical training.

One physician described a "rotary dislocation" in which the head of the humerus appeared to have turned completely around in the glenoid without coming out. He stated that this type of dislocation may be very difficult to visualize roentgenographically.

An officer from a general hospital reported five unreduced shoulder dislocations which appeared many weeks after the original injuries.

b. Recurrent.—The frequency with which recurrent dislocations of the shoulder are being observed in the Army is certainly an indication

that something is wrong with what is considered orthodox treatment of the original dislocation.

The Nicola procedure is the most popular operation for recurrent dislocation at this time, although the Bankart operation has many ardent supporters. The largest number of operations reported from one hospital was forty Nicola operations over a period of sixteen months.

Many poor results following Nicola operations are now appearing in the hospitals and dispensaries. In one general hospital, it was reported that eighteen patients who had had the Nicola operation were complaining of painful scars, and that nine of these patients had had a recurrence of the dislocation after operation. In a second general hospital, three postoperative dislocations had been observed. In a third general hospital, five Nicola operations had been performed and two recurrent dislocations following Nicola operations done elsewhere had been observed. It was stated that a follow-up of forty-seven Nicola operations performed at the University of Michigan had shown a recurrence rate of 15 per cent. It is believed by many that a similar or higher percentage obtains in the Army. This is to be compared with a recurrence rate of 4.6 per cent recently reported by Dr. Nicola.

An officer who had been associated with Dr. Nicola in civil practice was of the opinion that the principal reason for the large number of poor results is faulty operative technique. In a very careful review of the technique of operation and postoperative care as now advocated by Nicola, he emphasized the following:

1. A capsular strip one-half inch wide, left attached superiorly, should be pulled through the tunnel in the humeral head along with the biceps tendon. This provides strong reinforcement of the tendon.

2. The tunnel should be placed at an angle of 45 degrees to the shaft of the humerus. Failure to place the tunnel properly, he considered the most common cause of recurrence.

3. Care should be exercised not to injure the branch of the circumflex nerve which supplies the anterior portion of the deltoid muscle.

4. The shoulder should be immobilized for seven to ten days following operation. Abduction exercises should then be started, but the elbow is not to be extended beyond 90 degrees for three weeks; full use of the arm is not allowed until three months after operation.

One officer did not like the Nicola technique and used a modification of Roberts' technique, that is, placing the biceps tendon in a trough lateral to the bicipital groove. The trough is formed by lifting up a flap of bone and, after the tendon has been put in the trough, the flap is replaced. Postoperatively, a shoulder spica cast was worn for four weeks and full duty was not allowed for three months. The Bankart operation was

favorably reported on in two conferences; it is believed by many to result in a more stable shoulder and fewer recurrences than does the Nicola operation. One officer described the Cayo operation for recurrent dislocation; in this procedure the origin of the teres major muscle is transplanted from the scapula to the top of the shoulder.

It was repeatedly emphasized that a shoulder which has been dislocated postoperatively cannot be expected to stand up under the stress and strain of the obstacle course for commando training. Nevertheless, many soldiers with such shoulders are required to participate in these activities.

One officer stated that he had never seen a dislocation in a shoulder with a previous paralysis of the deltoid muscle.

(*Comment.*—The evidence on dislocations of the shoulder indicates that more attention should be given to immobilization of the original dislocation. If this is done, there will in all probability be fewer recurrent cases. I believe that the period of immobilization should never be less than three weeks and that preferably it should be six weeks. The routine use of a shoulder brace to prevent abduction for an additional period of eight weeks would be another safeguard against recurrence.

More careful selection of recurrent cases for operation should be made and the operation should be done only by those who are trained and experienced in its technique. The faulty technique of the inexperienced surgeon is undoubtedly one of the principal reasons for the high incidence of recurrences in the Army. I believe that the soldier who has had an operation for recurrent dislocation should never be qualified for full military duty.

The advocates of the Bankart operation believe that it results in a far more stable shoulder, less likely to be dislocated than following the Nicola operation. I have had no personal experience with the Bankart operation and cannot express an opinion concerning it; I believe, however, that it is worthy of consideration by more surgeons.)

5. *Miscellaneous Shoulder Conditions*

A case of a loose body within the shoulder joint was reported; the loose body caused a slipping sensation which a patient might confuse with dislocation.

It was recommended by one physician that every injured shoulder be examined carefully for damage of the axillary nerve, and that nerve suture be done immediately if evidence of rupture should be found.

(*Comment.*—It is doubtful whether rupture of a nerve can be ascertained immediately after injury. It would be better to delay operation until there is definitely no evidence of return of nerve function.)

One officer recommended strongly that lateral x-ray pictures of the shoulder, as well as the standard anteroposterior x-rays, be made routinely. The anteroposterior ones should always be taken first with the

arm in internal rotation and then with it in external rotation. Often one view will show an abnormality which does not appear in the other.

(*Comment.*—The lateral x-ray picture of the shoulder should be made with the x-ray tube in the axilla and the film on top of the shoulder while the arm is held in abduction.)

The treatment of painful subdeltoid bursitis, with and without calcareous deposits, was discussed in several conferences. There were numerous reports of relief of pain by needling, procaine injection, or irrigation of the bursa.

(*Comment.*—These procedures are certainly generally accepted for acute subdeltoid bursitis. Satisfactory results are being reported from all clinics.)

6. *Fractures of the Head and Neck of the Humerus*

Two officers were of the opinion that a fracture of the greater tuberosity with displacement always required an open operation whereby the tuberosity is fixed to the head with a peg or nail. Two physicians stated that for a fracture of the greater tuberosity the arm should be held in a position of adduction rather than abduction, as the latter position has a tendency to displace the fracture fragment. This is contrary to the usual teaching.

The hanging-cast method of treating fractures of the neck of the humerus was discussed at several conferences. Two officers were strongly in favor of its use for these fractures and one was just as strongly opposed. One physician reported eight good clinical results in a series of ten cases of fractures of the surgical neck of the humerus treated by the hanging-cast method.

(*Comment.*—The hanging-cast method is as valuable for the treatment of the uncomplicated fracture of the neck of the humerus as for the shaft and should be employed wherever possible.)

PART II. FRACTURES AND DISLOCATIONS OF THE ARM, FOREARM, AND ELBOW

The group of fractures and dislocations of the arm, forearm, and elbow does not constitute so high a percentage of the total fractures and dislocations in the Army as in civil practice. This group comprised twenty-eight cases or 5 per cent of the 580 fractures reported by one hospital. Of the arm, forearm, and elbow injuries, fractures of the head of the radius form the most common as well as the most serious problem.

1. *The Shaft of the Humerus*

According to the statistics, fractures of the shaft of the humerus in the Army Air Forces hospitals are relatively common. The main discussion in every conference concerned the value of the hanging-cast method of treatment. Three series of fractures of the shaft of humerus, of twenty, seven, and five cases respectively, were reported; in each

series the hanging cast had been employed with strong union of all fractures in a normal length of time. There was only one physician who did not prefer this method to all others for the treatment of these fractures. He was using skeletal traction through the olecranon with the arm in a shoulder spica at 90 degrees abduction. It was repeatedly emphasized that with the hanging-cast method great care should be taken to prevent distraction of the fragments. Frequent x-rays are indicated in the early stages of the treatment. In one hospital a very light arm cast was used and a small shot bag was fixed under the elbow portion of the cast. The weight of the cast could be varied by increasing or decreasing the shot in this bag.

It was the opinion of many of the officers that the hanging cast could be applied satisfactorily in the casualty station of the combat area. They recommended that under such circumstances the arm be fixed to the trunk for comfort during tranportation. This additional immobilization can be secured by applying a plaster splint over the cast across the shoulder to the neck and firmly securing cast and splint to the chest wall with bandages.

One physician was of the opinion that if reduction of a fractured humerus could not be obtained by a few days of conservative treatment, operation should be carried out and the fragments plated.

(*Comment.*—The value of the hanging-cast treatment of fractures of the shaft of the humerus has now been clearly demonstrated over a period of eleven years. The method has come to stay; the few bad results are most often due to failure of the surgeon to apply properly the accepted technique. For ten days to two weeks following fracture, the patient should not be allowed to assume a position in which the weight of the cast is not pulling down on the lower fragment. This will present little difficulty if the principle of the hanging cast is explained to the patient and his cooperation is secured. The surgeon should never allow distraction to occur, but should check with frequent x-rays in the first few days following application of the cast. If distraction is present, either the weight of the cast should be decreased or a new and lighter cast should be applied after gentle manipulation of the fragments into better position. Circumduction and rotation exercises of the shoulder should be started early and continued until the patient returns to full duty.)

2. *Fractures Involving the Condyles and Lower End of the Humerus*

There were frequent discussions of the operative versus the non-operative treatment of extensively comminuted fractures of the elbow. Dr. John Dunlop of Pasadena, Calif., reported several most satisfactory long-term end results in patients treated by the skin traction method which he first described in 1927 and which he still believes to be the best method for treating extensively comminuted fractures of the lower end of the humerus. This method was advocated also by two officers at

other conferences. Dr. Dunlop stated specifically, however, that if fractures of the condyles could not be brought into good alignment with the closed method, open operation should be performed and internal fixation used as indicated. Several officers expressed the opinion that open operation was indicated only if the closed method did not give a good anatomic result. Two physicians recommended the use of small Kirschner wires for the fixation of displaced condyles. One officer was using small plates and screws to fix the fragments of the T fracture. Two officers recommended the use of skeletal traction, with a Kirschner wire through the olecranon, for all fractures about the elbow which require traction. Many advised that this traction be applied with the shoulder in a spica cast in 90 degrees abduction. An officer and a visiting physician strongly recommended this type of immobilization for supracondylar fractures when traction is not required to maintain the reduction; they advised the spica cast particularly for children, because of the considerable danger that the fragments may slip after reduction.

(*Comment.*—Conservatism in the treatment of the extensively comminuted and displaced fracture of the elbow undoubtedly gives the greatest number of good results in the hands of the largest number of surgeons and should therefore be advocated for military surgery. The displaced single condyle which cannot be held in proper alignment should be fixed with a screw, wire, or nail, but I believe that there are very few other fractures of the elbow, with the exception of olecranon fractures, which should require open reduction.)

3. *The Head of the Radius*

In all conferences there was considerable discussion of the treatment of injury of the radial head. For incomplete fractures of the head of the radius or complete fractures without displacement the trend is distinctly toward early mobilization. When immobilization was used, it was seldom continued for more than two weeks. One officer recommended the application of hot packs every two hours for two days, followed by active motion and triceps exercises. In all conferences emphasis was placed upon active rather than passive motion. Two officers stated that if hemorrhage is present it should be removed from the fracture site by aspiration before motion is instituted.

For comminuted and displaced fractures of the head of the radius, early excision of the fragments and the head was recommended. Many officers believed that removal of the displaced fragment or fragments was sufficient if the fracture involved less than one-third of the articular surface. There was considerable variance in opinion regarding the choice of skin incision for approach to the head of the radius. One officer recommended a posterior incision, a second officer a posterolateral incision, and a third and a fourth officer an anterior incision. The

latter two believed that an anterior approach entailed less danger of subsequent extra-articular calcification.

There were numerous reports of excessive calcification about the elbow joint following removal of the head of the radius. One officer reported two patients observed in civil practice in which this abnormal calcification had caused complete ankylosis of the elbow, while a second officer reported two similar cases with only 5 and 10 degrees, respectively, of elbow mobility remaining. A third officer stated that this extra-articular calcification could be minimized by two weeks of immobilization following the removal of the head. Two officers believed that a good method of minimizing excessive extra-articular calcification after operation is to cover the end of the radius with muscle and soft tissue after excision of the fracture fragments and the remaining portion of the head. Everyone agreed that, if indicated, excision of the fragments and remaining portion of the radial head should be performed early, preferably on the day after fracture; however, it was very wisely stated "if there is any doubt as to whether the radial head should be removed, operation should be deferred until it is definitely established that removal is necessary for good function." It was stated at several conferences that, if not performed early, the operation should be delayed for several weeks.

It was stated that two other disabling complications following the removal of the head of the radius are: (1) radial deviation of the wrist with subsequent pain and weakness and (2) lateral instability of the elbow.

Thirty patients with fracture of the head of the radius were treated at one hospital as follows: twenty-four by the closed method with an average hospital stay of thirty-one days, and six by open operation with an average hospital stay of fifty-two days. Those patients upon whom motion was started not later than the fifth day definitely had the better end results in both groups.

A second hospital reported twelve cases in a period of fifteen months, five patients treated by the open method and seven by the closed. A third hospital reported six patients who were treated by the closed method and three by open operation, with excellent end results in eight of the nine. In the ninth case the patient required operation and slight limitation of flexion resulted.

(*Comment.*—The reports of excessive calcification following removal of the fractured head of the radius with resultant loss of elbow motion emphasize the extreme care which must be exercised in removing every small fragment of bone and periosteum. Whether the more difficult anterior approach will minimize this undesirable calcification, I cannot say, but this incision is definitely worth considering. When operation is indicated it should always be done either very early or very late, that is, after several weeks, and never during the period of new bone production immediately following fracture.

I have never observed lateral instability of the elbow or radial deviation of the wrist following removal of the radial head; I do not believe that they would constitute serious complications in adult patients.)

4. *Olecranon*

At several conferences the advisability of removing small comminuted fragments in olecranon fractures was discussed. One officer had removed the smaller fragments, carefully reapproximating the tendinous structures of the triceps tendon and maintaining approximation of the main fragments to the shaft with a screw. A second and a third officer had removed all of the proximal fragments.

(*Comment.*—I believe that it is a dangerous procedure to remove too many fragments of the olecranon following a comminuted fracture. I am definitely opposed to the complete excision of the olecranon process which is being advocated by some surgeons at this time.)

5. *Monteggia's Fracture*

The treatment of the syndrome of fracture of the upper third of the ulnar shaft and anterior dislocation of the head of the radius was frequently discussed, but only a few cases were reported. One physician suggested treating the ulnar fracture by inserting a Steinmann pin through the olecranon into the ulnar shaft and across the fracture line into the lower fragment. He was of the opinion that reduction of the dislocation of the radial head could be maintained by flexing the elbow after the ulnar fracture had been fixed in this manner. Excision of the head of the radius and this use of a Steinmann pin were suggested by another physician. An officer reported satisfactory results from plating the fractured ulna and constructing a fascial sling to hold the head of the radius in place, while two physicians recommended plating the ulna and repairing the orbicular ligament of the neck of the radius. There were no reports of the end results of any of these methods of treatment.

(*Comment.*—Constructing a fascial sling or repairing the orbicular ligament to hold the dislocated head of the radius in place is a difficult operative procedure and should only be attempted by those who have been trained in this type of surgery. Excision of the dislocated radial head is indicated if its reduction cannot be maintained but should not be done as an initial procedure.

Open operation with plating of the ulnar fracture is always to be preferred to external fixation of the fracture with a Steinmann pin.)

6. *Dislocation of the Elbow*

Dislocation of the elbow was frequently the subject of discussion. One officer advocated using an elbow sling for a period of two to three weeks after reduction and then allowing motion. A second officer re-

ported two previously unrecognized posterior dislocations of the elbow amongst overseas casualties. A third officer reported the very unusual combination of a posterior dislocation of the elbow with an olecranon fracture. This was followed by an excessive amount of extra-articular bone formation; however, with splinting and rest this abnormal bone completely disappeared.

(*Comment.*—I have personally seen large masses of abnormal calcification in muscles and in and about joints completely disappear with immobilization in plaster for periods of from eight to twelve weeks. I strongly recommend this treatment for all complications of this type.)

7. *Aftercare of Elbow Fractures and Dislocations*

The point was stressed in four conferences that under no circumstances should the manipulation of a stiff elbow after fracture or dislocation be allowed. Several tragic examples of such manipulation were reported. It was further emphasized by one officer that passive stretching, carrying weights, and hanging by the arm from a bar are all contraindicated. It was stated that too often the additional injury of the elbow by manipulation, forced passive motion, and stretching will result in a permanent decrease of mobility rather than an increase. Many officers were of the opinion that the recovery of mobility of the elbow following injury should be accomplished only by active use of the joint.

(*Comment.*—Too much stress cannot be placed upon the disastrous results which may follow manipulating and passively stretching an elbow after injury. The occasional good result does not justify the use of these procedures.)

8. *Volkmann's Contracture*

This condition must fortunately be extremely rare amongst military personnel, as no cases were reported at the twelve conferences. I have personally observed but one case in the Army. One physician, however, reported five civilians with circulatory embarrassment of the forearm and hand following elbow fractures; these were treated by procaine injection of the stellate ganglion and brachial plexus with improvement of the circulation. It was the opinion of this physician that each case represented a potential Volkmann's contracture.

(*Comment.*—Procaine injections of the sympathetic ganglia are being performed to improve the circulation in more and more conditions involving the extremities. Many times I have seen embarrassed circulation improve with such injections and I am of the opinion that this method should now be employed as a routine procedure in these conditions.)

9. *The Shafts of the Radius and Ulna*

There was little discussion of fractures of the forearm. Two officers recommended open operation on all displaced fractures, a plate being

used on one or both of the fractured bones. Two other officers stated that, if open operation is indicated, two incisions should be used rather than one because they entail less likelihood of synostosis from excessive calcification.

PART III. FRACTURES AND DISLOCATIONS OF THE HAND AND WRIST

Fractures and dislocations of the hand and wrist comprise the largest group of injuries observed in the Army Air Forces hospitals and dispensaries, constituting from one-third to one-half of the total number of fractures and dislocations. The common conditions divide themselves into four groups: those of the lower end of the radius, the scaphoid, the metacarpals, and the phalanges.

1. *The Lower End of the Radius*

a. Incidence.—Fractures of the lower end of the radius are not so commonly observed as in civil practice. A considerable number of Colles fractures, are reported; many of these, however, are actually other fractures of the lower end of the radius rather than the true Colles type. One hospital reported three fractures of the lower end of the radius in a series of 100 fractures of the hand and wrist; a second hospital reported 15 in a series of 280 fractures of the hand and wrist; this is an incidence of 4.7 per cent for the two hospitals. This figure is to be contrasted with an incidence of 11 per cent which was reported from the Massachusetts General Hospital Fracture Service several years ago. A third hospital reported 4 fractures of the lower end of the radius in a series of 110 fractures of the wrist alone. On the basis that fractures of the wrist make up approximately one-fourth of the group of fractures of both the hand and wrist, the incidence for the third hospital would be only .9 per cent.

(*Comment.*—A probable explanation is that the third hospital serves a field which is a cadet center, where the average age is approximately 20 years as compared with an average age of approximately 27 years on the other two fields. All fracture statistics show that fractures of the lower end of the radius are more common in the older age groups than the younger. This also explains the different incidence in the statistics from the Massachusetts General Hospital, where the average age of fracture patients is considerably higher than in the Army.)

b. Reduction and Immobilization.—The complete or nearly complete Cotton-Loder position of flexion and ulnar deviation after reduction was used for plaster immobilization by four officers. One of these officers was including the thumb to provide more rigid fixation of the hand. Two officers condemned the use of the full Cotton-Loder position because of the dangers of median nerve injury and of stiffness, and in its place recommended a position of slight flexion and ulnar

deviation. Two other officers recommended a neutral position. Only twice was it stated that the elbow was immobilized in treating these fractures.

(*Comment.*—This is surprising, as many doctors in civilian practice routinely incorporate the elbow in plaster after reduction of a Colles fracture.)

The officers who employed the full Cotton-Loder position spoke of changing the position to one of decreased volar flexion after two to three weeks; however, one officer was maintaining this position for six weeks. Two officers reported the use of wire traction through the base of the first metacarpal or the bases of all the metacarpals in order to maintain reduction in extensively comminuted fractures of the lower end of the radius.

Two officers enthusiastically recommended the traction method of Joldersma for reduction of fractures of the wrist. This is the use of fifteen pounds of traction on the hand, obtained through special finger splints, for a period of fifteen minutes.

c. Anesthesia.—Six hospitals reported the use of local anesthesia for the closed reduction. However, general anesthesia was more often used than local. Brachial block was occasionally the anesthesia of choice.

The only poor results were reported from hospitals where local anesthesia had been used. In one report there were three malunited Colles fractures in a series of fifteen cases.

One officer was strongly of the opinion that in the reduction of a Colles fracture "the operator should not be timid, but be brutal." He believed that the unsuccessful reduction of many of these fractures was due to the fact that the surgeon did not use sufficient force. This officer strongly condemned the use of local anesthesia, believing that with its employment there was too frequently an inclination on the part of the surgeon to stop short of a complete reduction because of the pain suffered by the patient due to incomplete analgesia.

(*Comment.*—It is my opinion, substantiated by this evidence, that local anesthesia should not be the anesthesia of choice in the Army for reduction of the fractured wrist, except in unusual circumstances.)

2. *Scaphoid*

a. Incidence.—The frequency of fractures of the scaphoid bone as contrasted with other fractures of the wrist is most striking. One hospital reported 91 fractures of the scaphoid in 110 fractures of the wrist alone, or an incidence of 80 per cent of the fractures of the wrist. A second hospital reported 47 in 280 fractures of the hand and wrist, while a third hospital reported 12 in 100 fractures of the hand and wrist; this is an incidence of 15.5 per cent of the hand and wrist fractures in these two hospitals. In one hospital with complete fracture

statistics for one year, the incidence was 8.1 per cent, which is to be contrasted with the incidence of .5 per cent in civilian life, stated by Key and Conwell in their textbook on *Fractures and Dislocations.* Six hospitals reported having treated the following numbers of scaphoid fractures: 91, 47, 23, 16, 12, and 9, or a total of 198.

b. Diagnosis.—In all the conference reports on these fractures there was little mention of the "sprained wrist" which later showed a scaphoid fracture, a condition so frequent in civil practice.

(*Comment.*—This is probably due to: (1) a more frequent use of the x-ray in the Army than in civil practice and (2) the medical officer's constant vigilance in looking for a scaphoid fracture in the injured wrist.)

One officer reported that tapping on the end of the finger tips will cause pain in the wrist in a large percentage of the cases of fractured scaphoid. A second officer stated that pressure against, and traction on, the thumb will often produce pain about the scaphoid if it has been fractured. A third officer reported a "ring sign" in the x-ray of the wrist as follows: "Fractures of the central portion of the bone are usually on somewhat of a tangent. Due to the fact that the breaks in the dorsal and volar cortices are not superimposed, these breaks will be seen as two lines, which fuse at the lateral aspects of the bone to form a ring."

In one series forty-five of forty-seven fractures occurred across the body or waist of the bone. Repeated emphasis was placed upon the fact that fractures of the waist were more serious than fractures of any other portion. Apparently, a bipartite scaphoid, which may be confused with a fracture, is more frequently observed than is generally believed. At one conference there were seven officers who had observed a bipartite scaphoid in the Army.

c. Immobilization.—It was agreed in every discussion that firm plaster fixation of the wrist, extending from the elbow to the knuckles posteriorly and the crease of the palm anteriorly and including the thumb, was essential for solid union. Ten hospitals reported immobilization of the thumb in abduction with the wrist in radial deviation. Five of the ten insisted that the plaster be extended to the tip of the thumb, while the other five carried it to a point just proximal to the phalangeal joint of the thumb. One officer believed that it was unnecessary to abduct the thumb but that it should be held firmly in plaster in a neutral position; however, he insisted that the plaster be well molded into the palm in order that the cast obtain a firm grip on the hand.

It was agreed at all conferences that immobilization should be continued until the fracture showed x-ray evidence of healing; this period usually is about twelve weeks. Many stated that union would occur in sixteen to twenty weeks; however, one officer expressed the opinion that it might occur in six weeks.

d. End Results.—The combined reports on the end results from six hospitals showed 195 of 198 scaphoid fractures, or 98.5 per cent, healed with solid union. This is to be contrasted with the average of approximately 80 per cent which is stated in some textbooks.

(*Comment.*—The explanation of this high percentage of unions is undoubtedly (1) early recognition and (2) proper treatment. It must be remembered that these figures are from hospitals with well-qualified orthopedic surgeons. The percentage of unions for all Army Air Forces hospitals and dispensaries would not be this high but would probably be well above 80 per cent.)

e. Nonunion.—Two officers preferred bone grafting for the old ununited fracture, but they reported only one good result. A third officer reported three patients who had bone graft operations performed with poor results and who were later discharged from the service on account of painful wrists. Each of two other officers reported one good result from drilling across the fracture line in an old nonunion. Another officer advised removal of the proximal fragment; however, four poor results following this procedure were reported.

It was generally agreed at all conferences that the results of operations for nonunion seldom allowed return to full military duty. Two officers stated that for military service the wrist with a nonunion of the scaphoid was generally preferable to the postoperative wrist, even though union had been obtained.

At one conference there were reported several patients whose x-ray pictures showed evidence of old fracture but who denied having had any wrist pain previous to the occurrence of a recent accident. The explanation is probably that these patients had old fractures with previous asymptomatic nonunions.

(*Comment.*—These reports on scaphoid fractures show that:

1. There is a high incidence of these fractures, especially among the younger soldiers at the cadet centers.
2. With early recognition and adequate treatment, a high percentage of unions can be expected.
3. In the Army, operative treatment of the old ununited fracture seldom leads to a good result and hence is never indicated, except for the soldier who can be placed on limited duty.
4. A bipartite scaphoid should always be looked for and, if suspected, should be investigated further by x-ray examination of the other wrist.
5. Many old ununited fractures are asymptomatic.)

3. *The Metacarpals*

a. Incidence.—One hospital reported thirty-two fractures of the metacarpals in a series of 280 fractures of the hand and wrist, an incidence of 12 per cent; another hospital reviewed a series of twenty-four fractures.

b. Treatment.—At all conferences it was agreed that a displaced fracture should be treated with skeletal traction, especially a fracture of the Bennett type (fracture dislocation of the base of the first metacarpal). One officer reported twenty-six good results in thirty-two metacarpal fractures following the use of skeletal traction through the nearest phalanx. A second officer expressed a dislike for skeletal traction; he recommended skin traction obtained by using stockinet with a cellulose acetate prepartion applied on the fingers and/or thumb. In another hospital, traction was obtained by the application of a towel clip through the distal end of the metacarpal just back of the head. This method is particularly applicable to fractures of the first metacarpal, especially the Bennett fracture, but can also be used for fractures of the second and fifth metacarpals.

Two officers disapproved of the use of a "roll of bandage" in the palm for immobilization of a metacarpal fracture, objecting to the resultant stiffness. One consultant was of the opinion that the best treatment for fractures of the metacarpals and phalanges is two weeks of immobilization, followed by a period of active physical therapy. He believed that too frequently the prolonged immobilization of these fractures is followed by poor results.

Knuckle fractures or fractures of the metacarpal neck were discussed in all conferences. The reduction was being satisfactorily accomplished in two clinics by flexing the metacarpophalangeal joint and pushing upward (in a dorsal direction) on the first phalanx and downward (in a volar direction) on the shaft of the metacarpal. Immobilization in this position was being secured by the use of plaster.

In undisplaced fractures of both the metacarpal bone and phalanx, one officer described excellent results following the injection of procaine into the fracture site and the early institution of motion.

Five officers discussed the use of Kirschner wires through two or more metacarpal shafts for immobilization of the fractured metacarpal, after the method described by Waugh, and Berkman and Miles. From one to three wires were inserted, and motion of the fingers and hand was started immediately. One officer reported a soldier who returned the next day to work as a mechanic. However, there was a report of two cases of infection of the hand following the use of this method.

One officer reported an arthrodesis of the first carpometacarpal joint because of pain in the hand following a Bennett fracture. Following this operation the hand showed excellent and painless function.

(*Comment.*—The Kirschner wire method for immobilization of fractured metacarpals should definitely be used only in selected cases, as the reports of infection of the hand show that the method is attended by an element of danger which cannot be disregarded.)

4. *Phalanges*

a. Incidence.—Fractures of the phalanges are by far the most common of all. One hospital reported 177 in a total of 280 fractures of

the wrist and hand, an incidence of 63 per cent. Another hospital reported that fractures of the proximal phalanx constituted 50 per cent of all fractures of the hand.

b. Baseball or Mallet Finger.—Baseball or mallet finger was discussed at all conferences. The results were in general so unsatisfactory that in many hospitals open operation had been frequently used in an effort to find a more satisfactory solution. However, one of these hospitals reported eight poor results out of ten patients operated upon, the operation having been followed by suppuration and the extrusion of black silk sutures. Needless to say, this hospital had discontinued the procedure. Two officers reported an open operation with the use of wire, tantalum in one instance and steel in the other. The ends of the wire suture were allowed to protrude through the skin, and later the suture was removed. Two good results, after six and twelve months, respectively, were reported with this procedure. The same procedure with the use of silk instead of wire was reported by another officer; his results were not given.

Everyone agreed that the correct position for the splinting of the finger is one of hyperextension of the distal phalangeal joint accompanied usually by flexion of the proximal phalangeal joint. This position was being maintained in two clinics by the use of a plaster thimble which extended from the tip of the finger to a point proximal to the first interphalangeal joint. The immobilization time was usually three to six weeks. One officer reported maintaining this same position by means of a circular adhesive dressing, beneath which felt pads were placed at the tip of the finger and distal end of the proximal phalanx. One hospital reported unsatisfactory results in 50 per cent of all patients who were treated with splints.

One officer stated that flying personnel with baseball fingers frequently reported the fact that at approximately 15,000 feet they were unable to use these injured fingers.

c. Treatment of Fractures of the Phalanges.—Skeletal traction was being rather generally used to maintain position of the fragments, especially when the fracture was near a joint and the fragments displaced. One officer reported inserting a surgical needle under the attachment of the flexor tendon to the terminal phalanx for traction. A second officer cautioned against the use of a motor saw in inserting wires through phalanges for skeletal traction.

A hairpin splint was being used in two clinics for the immobilization of the distal phalanx. A third officer reported the satisfactory use of the one-half inch steel tape from packing cases as a splint material.

A fourth officer reported improvement in finger function from arthrodesis of an interphalangeal joint after severe intra-articular fractures of the phalanges. The position of ankylosis was one of slight flexion.

(*Comment.*—The evidence certainly does not favor open operation for the baseball finger.

Arthrodesis for the malunited intra-articular fracture should be performed as a last resort and only when it is necessary for the relief of pain.)

PART IV. FRACTURES AND DISLOCATIONS OF THE HIP, THIGH, AND KNEE

The problems involved in injuries of the hip, thigh, and knee are fortunately seldom observed in the Army Air Forces station hospitals. Because these hospitals usually evacuate patients with major fractures, including most of this group, to the general hospitals, the reports from these station hospitals are not of great significance. At the conferences, reports were given of six patients who had fractures of the femur and who died of fat embolism following transportation to another hospital; all of these patients had been transported soon after injury. This information should sound a note of warning concerning too early transfer of patients with major fractures to other hospitals.

1. *Fractures of the Hip*

Fractures of the hip definitely do not constitute a problem in the Army hospitals. It is rather interesting to note that in a report of 366 cases of fracture of the hip in civil practice, there were only thirty-four patients, or 9 per cent, between the ages of 18 and 45 years, which are the age limits for induction into the Army.

There was a report of fifty patients treated in civil practice by the use of four Moore nails, with a follow-up of one year or longer. Solid union was present in 90 per cent of the hips. This percentage, of course, is much higher than that reported by most advocates of nailing for fractures of the hip.

At one large general hospital only two hip fractures were observed over a period of three years. One of these was malunited and the other ununited.

One officer reported the following operative procedure for nonunion of fracture of the hip: a subtrochanteric osteotomy was performed; a blade type of nail plate, such as is made for intertrochanteric fractures, was then used in a reversed position to hold the fragments approximated in their new alignment.

2. *Dislocations of the Hip*

In the Army, traumatic dislocation of the hip is observed much more frequently than fracture of the hip. In all discussions it was stated that when dislocation is associated with a posterior acetabular marginal fracture the dislocation should first be reduced; if the fragment remains displaced, an open operation is then indicated for its reduction and internal fixation.

The proper time to begin weight-bearing after dislocation was the subject of frequent discussion. One officer reported good results in five patients who had been allowed to bear weight after eight weeks; subsequently, however, repeated x-rays had been taken to show the head of the femur and investigate any possible changes in its shape. One physician recommended no weight-bearing for at least four months. Another physician suggested immobilization in plaster for seven to ten days after reduction, followed by motion in a bivalved cast and weight-bearing eight weeks after the injury.

(*Comment.*—The numerous severe jeep accidents and other major traumas observed in and about the airfields and camps are responsible for the frequency of traumatic dislocation of the hip. The question of when weight-bearing can be safely allowed is important. In the discussions, eight to sixteen weeks after injury was the time mentioned. I would prefer the longer period, but I would strongly advocate motion in two to three weeks if the acetabulum is not fractured and in eight to ten weeks if it is fractured.)

3. *Intertrochanteric Fractures*

Surprisingly few intertrochanteric fractures were reported. There were several reports of the successful use of a nail plate to maintain reduction of the fragments. One officer reported good results in thirty-nine cases treated in civil practice with a nail plate type of fixation.

(*Comment.*—I can recommend the use of either the blade type of nail plate of Neufeld or one of the various other nail plates for this fracture. I am of the opinion that not only are the anatomic and functional results more satisfactory than with the nonoperative methods but also the soldier can be safely returned to duty in less time.)

4. *Fractures of the Shaft of the Femur*

There was considerable discussion regarding the use of the external skeletal pin fixation method of Roger Anderson and Stader in the treatment of these fractures. Many unforunate results with x-ray evidence of osteomyelitis around the pin sites were reported. The opinion was expressed frequently that this type of fixation, if indicated at all, was indicated only for the special case with a severely comminuted or compound fracture, the reduction of which could not be maintained by other means. It was also agreed that the method should be employed only by those trained in its use.

One physician recommended the following treatment for the uncomplicated fracture of the shaft of the femur: (1) skeletal traction applied to the femur and adhesive traction to the lower leg, and (2) at the end of four months, weight-bearing in a walking caliper to be continued until one year after the injury. One officer recommended that indicated skeletal traction be obtained through the head of the

tibia in order to stretch the muscles of the thigh, which are usually contracted and spastic. It was stated by a second officer that in fractures of the lower third of the femur the traction should always be obtained through the lower fragment and not through the upper end of the tibia.

Ball-bearing pulleys to decrease friction and thereby increase the efficiency of traction apparatus were strongly recommended at one conference.

(*Comment.*—The indiscriminate use of external skeletal fixation by the inexperienced and untrained is the cause of much current condemnation of the method in the Army. It should be used with extreme care and only in selected cases.)

5. *Fractures of the Patella*

For fracture of the patella with separation of the fragments, purse-string sutures were recommended by three officers; two of these were using a strong steel wire, the third an absorbable material such as kangaroo tendon. There were numerous discussions regarding excision of the fragments of the patella in whole or in part. One officer from a general hospital reported four cases in which complete excision had been performed and had resulted in loss of full extension of the knee.

(*Comment.*—This evidence should certainly dampen enthusiasm for this procedure. I do not advocate a complete patellectomy.)

Many officers stated that they were removing small detached fracture fragments and carefully resuturing all torn ligamentous structures.

6. *Fractures of the Condyles of the Tibia (Plateau Fractures)*

Two officers and one visiting physician discussed in detail open procedures for fractures of the upper end of the tibia with displaced and depressed fragments. Two were in favor of putting a bolt through the upper end of the tibia to maintain the position of the condyles after open reduction. For the depressed fracture one physician recommended elevating the depressed fragment and placing a block of bone beneath it.

One officer was using a very ingenious hinged cast which allowed early motion; he recommended no weight-bearing, however, for three months. One physician stated that he always removed the semilunar cartilage adjacent to the fracture site at the time of operation, while a second physician did not remove the cartilage unless it caused symptoms after a return to bearing weight.

At one conference an officer pointed out that the results of open operation and metal fixation of these fractures were often very disappointing. He recommended that the conservative teaching of Mr. Watson Jones of Liverpool be followed, namely, forcing the knee into

varus or valgus, repositioning the fragments wth a clamp, applying a circular cast with the knee in varus or valgus, and applying traction through the cast.

(*Comment.*—Some of the most serious fracture problems are presented by the plateau fractures which we have to treat. I believe that the depressed and displaced fracture should be exposed by open operation, the fragment or fragments restored to as normal a position as possible, and the fragments then fixed in place with a bolt, screw, or nail. Following this, early motion is indicated, but weight-bearing should be delayed for at least twelve to sixteen weeks. These fractures, despite the best of treatment, seldom result in normal, painless knees.)

PART V. FRACTURES AND DISLOCATIONS OF THE LEG AND ANKLE

Fractures and dislocations of the leg and ankle constitute a large problem in the Army Air Forces hospitals, since fractures and dislocations of the ankle are the most common injuries except for those of the wrist and hand.

1. *Shaft of the Tibia and Fibula*

In a series of 100 fractures of the leg and ankle, there were 5 of the shaft of the tibia and 95 of the ankle, 82 of which involved only the external malleolus.

In all discussions it was generally agreed that for the oblique and displaced fracture of the tibia, in which the fragments cannot be maintained in alignment by traction, an early open reduction and internal fixation, preferably with a plate, is indicated. For fixing the fragments in long oblique fractures, one officer used two to four screws without a plate. He believed that in difficult fractures an open operation was far preferable to the risk of nonunion which might follow separation of the fragments by traction.

One officer was enthusiastic about the use of the three-section cast method in the treatment of fresh fractures of the shafts of the tibia and fibula. The upper and lower sections were first applied, then, after reduction, the middle section was added.

For treatment of the old fracture of the femoral or tibial shaft with overriding, one officer from a general hospital reported the successful use of skeletal traction obtained on a fracture table. The amount of traction was gradually increased until the overriding was corrected. The extremity was then immobilized in plaster, the pins used for skeletal traction being incorporated in the cast.

For the old fracture with absence of a section of the tibia, an officer reported the operation of fusing the lower tibiofibular joint. It was found that following this procedure the fibula often will hypertrophy to a sufficient size and strength to bear the weight of the patient.

One officer cautioned against using too much traction on the os calcis in treating fractures of the lower leg. In one patient he had observed as much as one-half inch of separation between the astragalus and the lower surface of the tibia. This stretching of the joint ligaments, he stated, might result in pain and a permanent relaxation of the ankle joint. A second officer reported that he had observed subastragalar joint pain after traction obtained by a Steinmann pin in the os calcis.

(*Comment.*—For the oblique and overriding fracture of the shaft of the tibia, internal fixation of the fragments is becoming more and more popular in many clinics and is the procedure of choice. It enables the patients to return to full military activity with fewer days lost from duty than after treatment by nonoperative methods.

Pain and disability in the ankle and subastragalar joints after skeletal traction applied to the os calcis can probably be avoided by using no more traction than is absolutely necessary to reduce the fracture and by continuing this traction no longer than is necessary to prevent slipping of the fragments.)

2. *The Ankle*

How to treat fractures of the external malleolus was a subject of discussion at every meeting. It was recommended by three officers that the undisplaced fractures be not immobilized in plaster but injected with procaine, supported by strong adhesive strapping, and allowed immediately to bear weight. However, a great many advocated the use of a walking cast for a period of two to four weeks. The treatment of minor fractures of the ankle and foot with and without plaster casts was reported from an infantry camp. The average time lost from duty was without plaster, thirty-four days, with plaster, fifty-seven to fifty-eight days.

An unusual case of nonunion of a transverse fracture of the external malleolus at the level of the ankle joint was reported.

For displaced fractures of the internal malleolus, especially when the fragment is rotated, it was agreed that in most instances the malleolus should be fixed to the tibia with a nail, screw, or bone graft. It was stated that often the periosteum became interposed between the malleolus and lower tibia and prevented union. The statement was made that walking casts definitely increased the incidence of nonunion of the internal malleolus and that they are contraindicated when this malleolus is broken.

For diastasis of the tibiofibular joint, one officer recommended the use of a vitallium screw, while another officer recommended using a bolt to fix the fibula to the tibia.

For fractures of the posterior malleolus with a large displaced fragment, accurate reduction and, if necessary, fixation by a screw or nail into the tibia were recommended.

(*Comment.*—The tendency is distinctly toward open operation for more accurate reposition of fractures of the internal and posterior malleoli. The necessity for such treatment is being constantly emphasized by the large numbers of soldiers who are unable to perform full military duty because of ankle pain following these fractures.

For fractures of the external malleolus not involving the joint, early mobilization and weight-bearing should be followed by better results than is prolonged plaster immobilization without weight-bearing. If a cast is applied, it should always be of a weight-bearing or walking type.)

3. *Sprains of the Ankle*

At most conferences there was considerable discussion of the treatment of the ankle sprain without fracture. An anteroposterior x-ray picture of the ankle with the foot in inversion with or without a previous procaine injection was strongly advocated by three officers. This view often will show a separation between the astragalus and tibia which is indicative of a ligamentous rupture. If such rupture is present, suture of the torn external lateral ligaments is to be considered. One officer reported 12 cases of severe ankle sprain, in three of which the torn lateral ligaments were sutured. The results were not given. The same officer reported the repair of a torn external lateral ligament by using the tendon of the peroneus brevis muscle.

At one conference there was a demonstration of treating the severe ankle sprain by the application of a skin-tight plaster splint cast similar to the Delbet walking plaster. This extended from below the knee to the plantar surface of the heel. Early weight-bearing was encouraged. It was reported that this treatment allowed an earlier return to normal activity than did other methods.

For mild ankle sprains, procaine injection of the tender areas with immediate weight-bearing was frequently recommended. With this method some reported excellent results with little or no time lost from duty; others had tried the method and abandoned it because of unsatisfactory results.

PART VI. FRACTURES AND DISLOCATIONS OF THE FOOT AND TOES

The incidence of injuries of the foot and toes is less than that of injuries of the ankle. Injuries to the toes are more common than are those of the foot.

1. *The Astragalus*

There were frequent references to aseptic necrosis of the astragalus following a fracture dislocation. Two physicians recommended that a subastragalar arthrodesis be performed a few weeks after this injury. Two officers were enthusiastic about the so-called wedge arthrodesis of Schrock for this fracture dislocation. In the Schrock procedure the body of the astragalus is removed; then all cartilaginous surfaces are

removed from the body as well as from the lower surface of the tibia and the upper surface of the os calcis; finally the body is reshaped to fit the space between the tibia and os calcis and is inserted therein. Two cases were reported with satisfactory end results following the Blair operation, which consists of sliding a graft down from the tibia to the head and neck of the astragalus after removing its body.

(*Comment.*—Fortunately, fractures of the astragalus are rare. It is always safe to recommend arthrodesis of the subastragalar joint when the fracture involves this joint and when there is persistent pain after healing. After fracture of the neck and dislocation of the body, there is little likelihood of a painless foot without an arthrodesis. The operations of Schrock and Blair are both sound procedures and can be recommended.)

2. *Scaphoid*

At one conference the unusual condition of scaphoiditis in a soldier 21 years of age was reported.

3. *Os Calcis*

Fractures of the os calcis are infrequently observed in the Army Air Forces hospitals. One officer recommended packing in ice the acutely swollen foot following this fracture. In all discussions emphasis was placed upon early reduction. It was reported from one general hospital that only one of approximately twent-five compressed and comminuted fractures of the body of the os calcis among overseas casualties had been reduced before arrival at the hospital. It was reported from another general hospital among many overseas casualties only two fractures of the os calcis had been reduced.

There was frequent discussion of the best method of reduction. Three physicians were enthusiastic about the Herman method, or its modifications, for reshaping the compression fracture of the os calcis. The statement was made that in a series of over 200 cases reported by Dr. Herman from civil practice, 75 per cent of the patients had returned to work in six to nine months. One officer made the statement that any fracture of the os calcis which extended into the subastragalar joint resulted in 25 per cent permanent disability, while a second officer stated that in his experience the permanent disability had been 35 per cent.

The statement was often made that involvement of the subastragalar joint indicates a triple arthrodesis as an early operative procedure, usually within three to four weeks after the injury. In the reshaping of the compressed and comminuted os calcis, emphasis was placed on the restoration of the tuber or salient angle, formed by the plane of the subastragalar joint, projected posteriorly, and that of the posterior superior surface of the os calcis. Normally, this angle is between 30 and 35 degrees. One officer was of the opinion that gradual weight-

bearing after the healing of the fracture was preferable to immediate full weight-bearing. He recommended starting with twenty-five pounds of weight-bearing on the heel and increasing this by another twenty-five pounds each two to three weeks.

It was the opinion of one officer that a soldier with a compressed and severely comminuted fracture of the os calcis was nearly always given a certificate of disability discharge (C.D.D.).

At one conference, which approximately 150 persons attended, this question was asked: "Have you returned one or more soldiers with compressed and comminuted fractures of the os calcis to full military duty?" No officer in the audience answered this question in the affirmative. At a second conference, one officer reported two patients with compressed fractures who returned to full duty, and a second officer reported that two of three patients with this fracture returned to limited duty only. At a third conference, two nurses were reported as returning to full duty. One consultant reported that five patients with simple fractures without comminution returned to duty. One officer made the statement that the British in some instances had concluded that the end result of treatment of a comminuted fracture of the os calcis was as satisfactory without reduction as with reduction.

(*Comment.*—The evidence certainly justifies the statement that very few soldiers are returning to full military duty after sustaining a severely comminuted and compressed fracture of the os calcis.

The method selected for the reduction should always be that with which the surgeon has had most experience and has obtained best results. The Herman method or any of its modifications is excellent.

After healing, gradual weight-bearing with the arches of the foot properly supported is to be recommended.)

4. *Metatarsals*

Metatarsal fractures are not of frequent occurrence, except those which come within the classification of "march fracture." The only discussion of metatarsal injuries other than march fractures was on the subject of avoiding plantar angulation in the treatment of fractures of the metatarsal shaft.

a. March Fractures.—March fractures are very common in all hospitals and dispensaries. Although some officers are still using walking casts, there has been a definite therapeutic trend toward less immobilization and earlier weight-bearing. There was one report in which thirty-seven patients with march fractures were satisfactorily treated by being retained in quarters for periods averaging ten to twenty-one days, after which strapping and an anterior arch support on weight-bearing were used.

An officer in an infantry camp reported that he had treated 105 march fractures in two years. He emphasized in diagnosis the im-

portance of dorsal pain and of always taking oblique x-ray pictures in addition to anteroposterior and lateral views. He had satisfactorily treated the last eighty fractures by splinting for the first eighteen to twenty-one days and limited walking for the next two weeks. He made the suggestion that these fractures might in some way be seasonal, as the greatest number had been observed during the month of June.

From another infantry camp came a report of 200 or more march fractures. The incidence varied from ten to forty a month and was always highest when the troops were on long marches. The treatment consisted of bed rest until the soreness disappeared and then gradual weight-bearing with an anterior arch pad in the shoe. One case of bilateral march fracture was reported.

One officer thought that stress and strain placed upon the second metatarsal head in doing "about face" or "to the rear, march" might be a causative factor.

There were reports that sixty men with march fractures had been sent to one general hospital and that forty had been sent to another general hospital. Some of these patients had been given so much prolonged rest that extensive bone atrophy, similar to Sudeck's atrophy, was present in the x-rays.

Among 313 march fractures reported from an infantry camp, 59.4 per cent involved the third metatarsal bone and 34.2 per cent the second; in the first x-ray pictures, 18 per cent showed no bone lesion and 40 per cent showed periosteal proliferation without a fracture line. This evidence substantiates the statement, made by several officers, that, "a soldier with clinical evidence of a march fracture should be treated, irrespective of a negative x-ray."

Fractures similar to a march fracture were reported as having been observed in the tibia, femur, pelvis, and ribs.

(*Comment.*—The tremendous volume of information on march fractures certainly opens up a new field of thought in bone pathology. Stresses and strains not associated with direct trauma but sufficient to cause a rupture of the normal continuity of bone have not been considered of great importance before; now that lesions similar to those in the metatarsal shafts are appearing in the tibia, femur, pelvis, and ribs, more attention must be given to the condition. The best treatment for march fractures, according to the evidence here presented, appears to consist of rest without rigid immobilization and of early weight-bearing with support of the anterior arch.)

5. *Toes*

At all conferences, emphasis was placed upon the absolute minimum of treatment for fractures of the toes, because of the danger of psychologic changes in patients with overtreated minor injuries.

Officers from two Air Service Command Depots reported a very high incidence of fractures of the toes. In both of these reports, emphasis was placed upon the use of a safety shoe. This shoe has a steel covering built into the shoe over the toe which forms a definite safeguard against fracture.

It was reported from one Air Service Depot that of sixty-one fractures of the toes, fifty-four had been caused by falling objects. The treatment had consisted of only procaine injection and strapping. The average time lost from work was 2.3 hours.

One officer described a plaster moccasin for the treatment of these fractures. The use of a small Kirschner wire under the periosteum of the phalanges for fixation of the more severe fractures was reported. One physician made a plea not to soak the foot in hot water, as he believed that hot soaks made the pain worse and the disability greater.

It was stated that a foot which has had one or more toes amputated is not a good foot for military service.

(*Comment.*—Fractures of the four smaller toes should be treated as little as possible. The great toe may require more treatment than the others. Early walking after fracture of a toe is unlikely to be harmful and should be encouraged.)

PART VII. FRACTURES AND DISLOCATIONS OF THE SPINE AND PELVIS

Fractures of the spine are relatively common; those of the pelvis are observed much less frequently. It is reported from one general hospital that of all men with fractures admitted, 11 per cent had fractures of the spine and pelvis.

1. *The Spine*

One officer made the plea that a single position be taught for transportation of men with fractures of the spine. He was of the opinion that the supine position was best and that instruction should be given regarding hyperextension of the spine for use when indicated.

(*Comment.*—The latest Army manual on first aid now teaches only the supine position for the transportation of those with a fractured spine. The British have found from experience that it is wise, in nearly all instances, to transport the patient with a fractured spine in the position in which he is found, being careful not to "fold the body.")

a. Cervical Spine.—The Crutchfield skull tongs are being used generally for traction on the cervical spine in fracture dislocations. One officer, however, preferred the Barton tongs. There were two reports of psychic changes following the use of tongs in the skull, that is, a "tong psychosis." At one conference a plea was made for using tongs no more frequently than absolutely necessary. One officer suggested applying fifteen to twenty pounds of traction to the tongs, taking a lateral x-ray picture of the cervical spine after fifteen to twenty minutes, and, if the dislocation is reduced, decreasing the traction to

ten to twelve pounds. He believed the tongs should be left on for a period of only three to four weeks and followed by a plaster jacket of the Calot or Minerva type.

Another officer recommended taking lateral x-ray pictures with the neck flexed if the first films were negative and fracture was suspected. It was stated that injuries of the seventh cervical vertebra were most often missed in the x-ray examination.

There was a discussion regarding fusion of the cervical spine for fracture dislocation. One officer from a general hospital reported two successful fusions for fracture dislocation. A second officer was of the opinion that in such an operation only two vertebrae should be fused. It was stated at one conference that, by means of traction, a dislocation of the cervical spine could be reduced up to six to eight weeks from the time of injury and that this was not true of dislocations in other parts of the spine.

The "two mattress" technique of allowing the head to hang over a first mattress onto a second to secure hyperextension was described. One officer preferred the Schanz cotton collar to support the head and neck in all cervical spine injuries not requiring traction or rigid fixation.

(*Comment.*—The desirability of minimizing the length of time for leaving "skull tongs" in place is evident. A "tong psychosis" may prove to be a very serious complication and the use of tongs is not always essential.

Cervical spine x-ray pictures in the anteroposterior and lateral positions should always be very carefully made. If they are negative and the clinical evidence points to bone injury, lateral x-ray pictures should be made with the cervical spine flexed as suggested.)

b. Lumbar and Dorsal Spine.—The question of the best type of reduction for compressed fracture of the vertebral body was repeatedly discussed. Dr. John Dunlop, of Pasadena, described his method of hyperextension with Goldthwait irons, used since 1927 on 180 cases. He reduces the compression immediately unless there is an impending paralytic ileus, in which case he waits six or seven days. He stated that paralytic ileus is a complication in approximately 30 per cent of these fractures. He was of the opinion that early ambulation is contraindicated and that bony union occurs in about four months. He, as well as another physician, made the statement that it is useless to attempt to reduce a compression fracture of the body of a dorsal vertebra above the tenth dorsal, as it is seldom possible to accomplish a reduction.

Several physicians recommended immediate reduction by forced hyperextension, application of plaster in the hyperextended position and allowing the patient to walk, in one instance in eight to ten hours after reduction and in another instance in twenty-four to forty-eight hours. In contrast with this, one orthopedic surgeon was of the opinion that these patients should be kept in bed for six to eight weeks after

injury, and another advised bed rest for three to four months. The advocates of immediate ambulation in plaster stated that it is important to maintain a snug fit by changing the cast when it becomes loosened. Several physicians stated that the cast should always be followed by a brace. It was reported that one prominent English orthopedic surgeon thought that muscle development was more important than reduction of the fracture. There was a report of pressure ischemia and slough over a part of the back after the use of a Ryerson automobile jack to secure hyperextension.

A medical officer in a processing center reported twenty-two patients with compressed fracture of the body who returned to limited duty, while one officer from a general hospital thought that most patients with fractured spines would eventually be given certificates of disability discharge (C.D.D.).

An officer from a general hospital reported several cases in which the os calcis, spine, and skull were fractured.

It was reported that a pilot who jumped from a plane felt something snap in his back as he was spinning around in his parachute. X-rays showed later that he had a compression fracture of the body of the twelfth dorsal vertebra. Eight compression fractures of bodies of the vertebrae were reported as occurring in soldiers who attempted to hold down several planes in a high wind. The mechanism of injury was the same for all, namely, forced flexion of the spine as the planes suddenly dropped to the ground after being lifted by the wind.

A case of posterior displacement of a vertebral body with complete paraplegia and herniation of the diaphragm was reported. Another report from a general hospital described six or more cases of ruptured diaphragm in overseas casualties associated with fracture of the body of a vertebra. The vertebrae involved were the sixth to the eighth dorsal.

An officer stated that arthritis often develops above and below the level of fusion for a dorsal or lumbar fracture and that fusion is seldom indicated.

(*Comment.*—I favor bed rest in plaster for four to six weeks after the reduction of a compression fracture of the lower dorsal or lumbar spine. This should be followed by a gradual return to walking in a plaster jacket.

The reduction of compression fractures of the middle and upper dorsal spine is never satisfactory. Some British sources have reported not attempting to reduce these fractures when there are no neurologic changes but treating them symptomatically only. The end results may be just as satisfactory with this method as with any other; however, I would favor at least six weeks of absolute bed rest as the initial treatment.

Following convalescence from a compression fracture, most soldiers should be placed on limited duty; a few may do well on full duty, but

undoubtedly many will not be able to readjust themselves to military activity and may have to be discharged from the Service.)

c. Transverse Processes.—It was repeatedly emphasized that when one or two transverse processes are fractured the best treatment consists of adhesive strapping and rest in bed without plaster immobilization. As in all spine fractures, physical therapy, including exercises to strengthen the back muscles, is indicated as soon as practicable. One officer was of the opinion that nearly all of these patients could be returned to duty in six weeks. To avoid the possibility of psychologic complications, a second officer emphasized the need of avoiding the term "broken back" and of telling the patient that he has a strain or sprain of the back.

d. Spinous Processes.—Several officers expressed the opinion that treatment of fractures of the spinous processes should be similar to that described for the transverse processes. A contrasting opinion, however, was expressed by one officer who thought that the treatment should consist of aspiration of the hematoma and immobilization in plaster in hyperextension for eight to ten weeks. If pain persisted and remained localized to the fractured area, he then advised removal of the fractured spinous process.

(*Comment.*—In the past there has been a tendency to overtreat fractures of the transverse and spinous processes. The convalescent period will be distinctly less with a minimum of immobilization and rest; the end results will be just as satisfactory. It is believed that localized pain persisting after fracture of a spinous process is due to nonunion and that the fragment should be excised.)

2. *Pelvis*

Discussion regarding fractures of the pelvis was extremely limited. Very few cases were reported. One officer from a general hospital gave the following suggestions for treatment, in addition to rest in bed on a fracture board:

1. A pelvic girdle is indicated for fractures of the anterior arch of the pelvis.
2. A suspension hammock is indicated for fractures of the posterior arch.
3. Traction should be applied to the corresponding lower extremity if one side of the pelvis is displaced upward.

One officer made the statement that weight-bearing can be allowed in four weeks if the fracture is not extensive and if the acetabulum is not broken.

A second officer described an intrapelvic approach for reduction of acetabular fractures and central dislocations of the hip.

(*Comment.*—In the treatment of fractures of the pelvis, the question of the proper time to allow weight-bearing always arises. It may be

that four weeks is a perfectly safe time in the case of simpler fractures not involving the acetabulum, but for all others, twelve weeks is the safest period.

It is my opinion that in the Army, due to the fact that trauma is often much more severe than in civil practice, more injuries of the bladder and urethra are observed in association with fracture of the pelvis.)

PART VIII. COMPOUND FRACTURES

The magnitude of the problem of compound fractures in time of war is exemplified in the statistics from the Veterans' Administration of World War I. From 1919 to 1926 there were 22,954 compound fracture cases in the records of the Veterans' Administration. Of this number, 4,053, or 17.6 per cent, of the men had osteomyelitis, and 4,244, or 18.5 per cent, were being compensated on the basis of a total disability. With the use of sulfonamides and penicillin in World War II, the percentage of osteomyelitis cases in the compound fracture group will certainly be less, but the totals will undoubtedly still be impressive.

As very few persons at the conferences had had actual experience in the combat areas, the discussions were, in most instances, based on experiences in station and general hospitals in the continental United States. Emphasis was repeatedly placed on the teaching that compound wounds should not be closed. However, there were reports of good results after the closure of compound wounds in station hospitals, where definitive treatment had been given within the so-called safe period of six to eight hours after injury; all of these patients were treated before the most recent directives of The Surgeon General's Office on this subject were published. Two disastrous results, however, were reported from station hospitals in cases in which the wounds had been closed and gas gangrene had developed.

(*Comment.*—In time of war there should be only one teaching on the subject of closure of the wounds of compound fractures: *They should not be closed.* There is always an element of chance in closing such a wound, and among military personnel this risk should not be taken. The report of two disastrous results following wound closure is sufficient evidence to emphasize this point.)

In nearly every clinic the treatment of compound fractures now involves the use of one or more of the sulfonamides. Sulfathiazole or sulfadiazine is often given by mouth, and usually sulfanilamide is sprinkled or dusted into the wound. One physician recommended sulfathiazole dissolved in water, however, as an instillation for wounds. One of the objections to the local use of sulfathiazole has been that it tends to cake and act as a foreign body; however, in aqueous solution it will not cake.

At this time the most pertinent subject in the discussion of infections is the place of penicillin, its use as a preventive as well as a curative agent, and its relationship to the sulfonamides. In five of the

conferences there were reports of seemingly miraculous results with the use of penicillin for infections. One physician from a general hospital reported use of the drug locally for infected areas; it was applied in the form of a wet dressing, 250 units being used per cubic centimeter of fluid.

(*Comment.*—With more information now becoming available on penicillin, which apparently is more effective than the sulfonamides, many of our ideas on chemotherapy will undoubtedly be changed. It may be that penicillin will be used eventually as a preventive agent. At the present time the volume of production of the drug is not sufficient for such use.)

A report from the North Africa theater contained the information that excellent results followed the plating of twelve compound tibial fractures through incisions away from the open wounds.

(*Comment.*—I believe that plating of a compound fracture, regardless of where the incision is made, should not be recommended for the medical officer in the combat zone. For carefully selected cases it may occasionally be an appropriate procedure.)

No large series of fresh compound fractures were reported at the conferences. The largest number of fresh cases was reported from an Army Service Force station hospital in Texas, where fifty to sixty compound fractures had been treated in ten months. The largest number of old cases was reported from a general hospital which had received 100 or more men with compound fractures from the South Pacific. They had arrived three to four months after injury. They were all in excellent condition in plaster.

One general hospital gave a report of sixty-four compound fractures among overseas casualties. Of this number, some of whom were still under treatment, it was estimated that forty-six, or 72 per cent, would be returned to military duty of some type, while eighteen, or 28 per cent, would be discharged from Service. The officer who made this report discussed gas bacillus and tetanus infections. He stated that he had never observed gas bacillus infection to begin after ten days from the time of the compound injury, nor tetanus infection after three weeks. From this observation he concluded that it would be perfectly safe to perform the secondary closure of a compound wound after a latent period of three weeks.

(*Comment.*—Three weeks is probably too early for the closure of a potentially infected wound.)

One of the outstanding reports of the conferences was made by an officer who had been with the troops on Bataan in the Philippine Campaign of 1941-1942. He reported that: (1) from 5 to 6 per cent of all hospital patients had compound fractures; (2) 90 per cent of all the wound cultures from compound fractures showed a gas bacillus; (3) all wounds were left wide open and some were irrigated with peroxide; and. (4) when indicated, early amputation was performed at the line of

demarcation of the gangrene. Final statistics showed the amazingly low mortality rate of approximately 1 per cent.

(*Comment.*—This is an outstanding result which shows what can be accomplished when certain basic surgical principles are rigidly followed.)

A group of prisoners with infected compound fractures at a Prisoner of War Camp in Texas was reported. The prisoners had recently been brought from the combat theater in North Africa. Very little sulfanilamide had been used initially on any of the wounds. Usually they had been packed only with iodoform gauze, after tincture of iodine had been applied as an antiseptic. In the series of twenty-four compound fractures, there were twelve cases of osteomyelitis.

Doctor H. Winnett Orr, of Lincoln, Neb., in discussing the treatment of compound fractures by his closed plaster method, emphasized the point that the key to the treatment is "prolonged, uninterrupted, and continuous immobilization," as originally advocated by Mr. Henry O. Thomas, of Liverpool.

The late treatment of a purulent compound fracture by débridement, plating, and dusting with sulfanilamide was reported. The result was strong union with complete healing of the wound.

A question discussed at several conferences was the correct emergency treatment of compound leg or thigh fractures in which the bone ends are dirty and sticking through the skin, particularly when such fractures occur near a well-equipped hospital. At one conference twenty-two persons were in favor of cleaning the wound and bone ends and applying a dressing and a traction splint before transporting the patient to the hospital, while eighteen were in favor of cleaning the wound and bone ends, applying a dressing and then transporting the patient to the hospital without applying a traction splint. This variance of opinion was also expressed at other conferences.

(*Comment.*—I am in favor of immediately cleaning the wound and bone ends and then applying a traction splint before transportation. This, I believe, definitely minimizes the danger of shock.)

PART IX. CONDITIONS INVOLVING THE BACK

The most effective treatment of the soldier with a low back complaint has been a major question on the orthopedic services of all hospitals and has in reality been the only important problem concerning the back.

1. *Incidence*

The incidence of low back conditions in the Army Air Forces hospitals has been 15 to 35 per cent in the outpatient departments and 10 to 30 per cent, in the wards. One clinic reported that 50 per cent of those with back pain examined in the outpatient clinic were admitted to the hospital. At one processing center it was reported that in a series

of approximately 1,000 soldiers, 22 per cent of the orthopedic examinations were for low back pain.

At a large infantry training center in the South, it was reported that 320 soldiers with back pain had been admitted to the wards of the station hospital; during the same period a total of 47,900 patients were admitted to this hospital; here the incidence was .66 per cent. It was reported that a general hospital had admitted 258 soldiers with back pain during a period in which total admissions were 6,800; this is an incidence of 3.8 per cent. It was reported from another general hospital that approximately 2,500 soldiers with back pain were admitted over a two-year period; 175 were admitted in one period of two months. These figures show the magnitude of the problem.

2. *Symptomatology*

The complaints of the patients vary from mild backache to acute pain with or without radiation into the lower extremities.

The most significant discussion concerned the psychogenic aspect of low back pain. There is no doubt that a soldier who has a back complaint and who wants to be discharged from the Army or to be relieved from doing a disagreeable duty has a strong argument to aid in accomplishing his aim. How to diffentiate the true malingerer and the mild exaggerator from the honest patient was the topic for discussion at all conferences. Some officers were of the opinion that a psychiatric examination was essential for the diagnosis and treatment of every patient with chronic back pain.

The diagnosis of rupture of an intervertebral disk was frequently discussed. A physician from a large civilian orthopedic clinic reported that 10 per cent of all the patients with low back pain and sciatica in his clinic have a ruptured disk. He further stated that it was reported from the Mayo Clinic that 13 per cent of 5,500 patients with low back pain and sciatica had shown a ruptured disk at operation. The statement was made that 75 to 80 per cent of all the patients in this group had had back pain prior to the onset of their neurological symptoms. One neurological surgeon was of the opinion that 90 per cent of all low back pain with sciatica is due to a ruptured disk. An orthopedic surgeon maintained that unless the spine were fused after rupture of a disk, there would be continued back pain due to facet changes associated with narrowing of the disk. At one conference it was stated that loss of the ankle jerk reflex is often associated with sciatic neuritis in the absence of rupture of a disk.

Back and leg pain may come from localized tender points of infection or trauma as a reflex phenomenon. It was stated that this type of pain exists far more often than it is generally believed. To differentiate this pain one officer and one visiting physician recommended the injection of procaine into the tender areas, which are termed "trigger points." If the pain is made worse when the needle is first inserted and disap-

pears with the injection of procaine, the pain is presumably referred from this "trigger point." Permanent relief was sometimes obtained by repeated injections of procaine into these points.

3. *Classification*

One officer classified these low back problems into four groups: (1) arthrogenic, (2) myogenic, (3) neurogenic, and (4) psychogenic. He reported a glove type of hypalgesia of the lower extremities in a series of 200 or more of these patients with low back pain; these cases, observed over a period of three months, he considered to be of the psychogenic type. Hypesthesia was also mentioned as being present frequently in the patients in this group.

An analysis of a series of 304 patients admitted to one station hospital was as follows: lumbosacral strain, 25 per cent; postural strain, 16.5 per cent; arthritis, 15.7 per cent; psychoneurosis, 6 per cent; spondylolisthesis, 4.4 per cent; rupture of the intervertebral disk, 1 per cent.

The following analysis of 79 patients admitted to a second station hospital over a period of one year was presented: (1) acute muscular or ligamentous strain, 29; (2) lumbosacral and sacroiliac strain, 21; (3) psychoneurosis and hysteria, 9; (4) arthritis, 7; (5) undiagnosed, 6; (6) scoliosis, 4; (7) rupture of intervertebral disk, 2; (8) spina bifida, 1.

(*Comment.*—The variance in classification of these low back conditions is striking. The adoption of a uniform classification would be of great value; however, opinions of the nature of the lesions in the different conditions vary so widely that it is doubtful whether such a classification could be adopted at this time.)

4. *Treatment*

All types of therapy were discussed and were being used. It was emphasized particularly by four officers, as well as by other physicians, that every hospital should have a definite program for the diagnosis and treatment of these back injuries and that after adoption this program should be rigidly followed. Most of the officers from station hospitals thought that because of time limitations in station hospitals, their treatment of the chronic back conditions was never satisfactory. Several were of the opinion that if no improvement was evident after two to three weeks of active treatment in a station hospital, a further disposition of the patient should be made. Many, however, did not believe that this period of time was long enough.

There were many discussions of the value of manipulation of the low back. It was the opinion of many officers that manipulations should be performed very carefully and only in selected patients.

Plaster immobilization was discussed infrequently. One naval officer reported the successful use of short plaster casts for certain types of low back pain.

It was agreed at all conferences that operative procedures for ruptured intervertebral disks should be performed only by neurological surgeons. In two conferences there was described an operative technique for placing a block of bone between the vertebral bodies after the ruptured disk tissue has been removed.

(*Comment.*—Placing a block of bone in the intervertebral space after the removal of disk tissue may result in less localized postoperative pain and weakness. It is certainly a technique which should be thoroughly tested before a final decision on its value is reached.)

5. *Disposition*

Of 320 patients treated at a large Army Service Forces station hospital, 248, or 77.5 per cent, were returned to duty; 44, or 13.7 per cent, were given a certificate of disability discharge (C.D.D.); and 28, or 8.7 per cent, were sent to a general hospital.

Of 304 cases reported from an Army Air Forces station hospital, 35 per cent of the patients were given a certificate of disability discharge for arthritis, scoliosis, or spondylolisthesis; 37 per cent were improved sufficiently to return to duty; 13 per cent were diagnosed as psychoneurotics and transferred to the neuropsychiatric service; 10 per cent were diagnosed as malingerers and discharged to duty; and 5 per cent had back pain secondary to a more serious condition and were transferred to other services. Another station hospital reported that 18 per cent of 79 patients were given certificates of disability discharge.

The figures on the disposition of patients in two general hospitals were most discouraging. The report from one hospital showed that of 310 patients, 72 per cent were given certificates of disability discharge and 28 per cent returned to duty over a period of one year. The report from the other general hospital showed that of 108 patients, 55 per cent were given certificates of disability discharge and 45 per cent returned to duty.

The disposition of the malingerer presents a most serious problem. If malingering can be definitely established, which is most difficult in the case of back complaint, the patient is sent back to duty or dishonorably discharged from the Army. In patients suspected of malingering, methods such as keeping the patient in bed without pajama pants and allowing him no bathroom privileges were reported from many clinics with various results.

(*Comment.*—The evidence as presented is certainly definite that the treatment of the low back complaint in the Army is unsatisfactory. It was thought by many at the beginning of World War II that having large groups of these soldier patients for observation and treatment might throw some light upon the problem. So far, the evidence does not suggest that this has occurred. It is to be hoped that, as the war goes on, the medical officers will give more careful thought and attention to this problem.)

PART X. CONDITIONS INVOLVING THE KNEE

In the Army Air Forces hospitals, the results of care of the disabled knee are definitely better than the results of care of the disabled back. Because of the great number of soldiers now appearing in the Army Air Forces orthopedic clinics and showing poor results following knee surgery and inability to perform full military duty, the trend is distinctly away from surgery.

1. *Statistics*

It was reported from one station hospital that over a period of one year approximately 1,000 soldiers disabled by knee injuries had been observed and thirty operations had been performed, an operative incidence of 3 per cent. From a second station hospital it was reported that during the last six months approximately 3,500 hospital days were credited to knee injuries (an average census of twenty knee patients a day), and that during the last eighteen months 100 or more knee operations had been performed. From three station hospitals of comparable size, there were reports of sixty-one knee operations in ten months from one; sixty-two knee operations in thirteen months from another, and sixty-eight knee operations in fifteen months from the third.

2. *Diagnosis*

There was frequent discussion of the so-called MacMurray sign, sometimes called the "click test." This sign is a click when the knee is flexed, adducted, or abducted and the tibia externally or internally rotated on the femur. A positive click test is usually indicative of a lesion in the posterior portion of the knee, most often in the posterior horn of the semilunar cartilage. It was reported from one hospital that 20 per cent of a series of soldiers with knees operated on showed a positive MacMurray sign, suggesting an incomplete operative removal of the cartilage. It was noted by one officer that in a series of seventy-seven patients, some knees which showed a posterior tear of the semilunar cartilage at operation had had negative MacMurray signs before operation.

In one conference it was said to be important to take an anteroposterior x-ray picture of the knee with the joint flexed to 90 degrees in order to show the intercondylar fossa. This will often demonstrate a loose body or an osteochondritis dissecans which cannot be seen in the routine anteroposterior and lateral x-ray pictures. When rupture of an internal or external collateral ligament is suspected, it was recommended by one officer that anteroposterior x-ray pictures of both knees in abduction or adduction be taken in order to show the difference in the amount of separation between the tibia and femur.

Two officers reported the use of air injected into the knee joint as an aid in the diagnosis of doubtful cases. Approximately 150 c.c. of air were injected after aspiration of the joint fluid, and x-ray pictures were then made.

In routine examination of the knee after injury, one officer reported finding frequently an injury of the upper tibiofibular ligaments, which he believes is a more common finding than is generally supposed. In the seventy-seven patients with knee injuries already mentioned, "locking" was a definite sign in twenty-one acute injuries and was the predominant symptom in forty-three. In this series, localized tenderness was a persistent and constant sign.

One orthopedic surgeon was of the opinion that in acute knee injuries the most common cause of the so-called "locked" knee is flexor muscle spasm. He thought that later this may be accompanied by quadriceps paralysis or paresis.

(*Comment.*—A positive MacMurray sign is helpful in diagnosis but should by no means be considered conclusive evidence that a lesion is present in the posterior compartment of the knee. This was clearly demonstrated in the series of seventy-seven patients.

I believe that the anteroposterior x-ray picture of the knee flexed to 90 degrees should be made routinely when an x-ray picture of the knee is indicated.

Judging from my own experience and that of many others, I do not believe that air in the knee joint is of sufficient value as a diagnostic aid to warrant its use except in the occasional case.

There is no doubt that too often, when an injured knee cannot be fully extended actively or passively, the assumption is erroneously made that there is a loose body or displaced semilunar cartilage between the joint surfaces; in reality, flexor muscle spasm is often the etiological factor. In no event should surgery be considered for the acute knee injuries until sufficient time has been allowed for rest and hot applications to relax the muscle spasm.)

3. *Treatment*

a. Conservative.—In all conferences it was agreed that acute knee injuries should first be treated conservatively unless unusual indications for early operation were present. Most officers were treating the early case with rest in bed and hot applications with or without traction. For sprains with localized tenderness, the injection of 1 to 3 c.c. of 1 per cent procaine into the tender area and early active motion were recommended at one conference. Two doctors were of the opinion that a locked knee should never be manipulated.

It was very frequently stated that the knee with an effusion should be aspirated, particularly if the fluid is bloody, as such an effusion, if left in the joint, will predispose to the formation of adhesions. In the treatment of a series of 200 acute knee injuries in one hospital, it was reported that all except one required aspiration.

(*Comment.*—Whenever manipulation is indicated in order fully to extend a knee, it should be carried out with extreme care.

The aspiration of a swollen knee should be more frequently performed than it is at the present time. The fear that a needle may carry infection into a sterile joint has made many physicians extremely cautious about aspiration. I have never seen an infection from aspirating a joint and am of the opinion that swollen knees which have been aspirated have a definitely shorter and more satisfactory convalescence than those which have not been aspirated.)

b. Operative.—Mental stability is considered a prerequisite for undergoing any type of knee joint surgery or any other elective military surgery. Some officers were of the opinion that a psychiatric evaluation of the patient is indicated before all elective surgery.

(*Comment.*—I believe that psychiatric consultation is necessary only in selected cases.)

Consideration of operative technique and postoperative care included discussion of the use of the tourniquet, the type of incision, the necessity for removal of all or part of the cartilage, the type of suture material, the type of dressing, the type of physical therapy, and the time for starting motion and weight-bearing and for returning to duty.

One officer had used a tourniquet in approximately 50 per cent of his patients with knee operations. This officer and another were of the definite opinion that there is less postoperative swelling and effusion without the use of a tourniquet than with it. Most surgeons were using a mid-thigh tourniquet. Two tourniquet paralyses with foot drop were reported. One patient recovered completely in two and one-half months, while the recovery period of the other was not reported.

The short versus the long parapatellar incision was discussed at many of the meetings. Many more officers were in favor of the short incision than the long. One physician stressed the possible psychic effect of the long incision on the soldier. Another reported that he had observed excessive quadriceps atrophy following the use of the long incision. An additional posterior incision for removal of the posterior portion of the cartilage was advocated by several officers. The Bosworth incision, which allows exposure of both the anterior and the posterior compartments of the knee through one skin incision, was also recommended by several officers.

It was the opinion of many operators that all of the injured semilunar cartilage should be removed, even if a separate incision were required. Two older orthopedic surgeons, however, were of the opinion that in a bucket handle injury only the displaced portion of the cartilage should be removed. One officer was using a tenotome, inserted into the posterior portion of the knee and visualized through the anterior incision, to incise the posterior attachment of the cartilage. This officer believed that a great deal of the postoperative bleeding occurs from the subpatellar fat pad.

For suture material, black silk, cotton, and a fine chromic catgut were being used.

Many of the officers applied a large cotton compression dressing from the toes to the groin after operation. Only two physicians reported splinting the knee following operation.

Quadriceps exercises were usually started from twenty-four to forty-eight hours after operation, and motion on the second to the fifth day. One officer recommended crutches as early as the third day. Weight-bearing was usually advocated in from five to twelve days. However, some officers did not allow weight-bearing until full motion had been restored, and one officer did not allow it until the quadriceps had regained its tone and strength. The hospital stay varied from ten days to four weeks.

The time of return to full duty varied from five to eighteen weeks. One well-known British orthopedic surgeon was quoted as stating that twelve weeks is the average time for return to duty.

One officer reported having observed approximately 200 bad results from knee surgery in one station hospital. He was of the opinion that most of the poor results were due to faulty surgical judgment and technique. One officer reported the instability of the joint as the most common postoperative complaint. Mention was made of an end result study of 670 knees operated upon for internal derangement by a prominent civilian orthopedic surgeon; only 20 per cent of these operations were considered completely successful and curative.

Two well-known orthopedic surgeons stated that a hypermobile cartilage without evidence of tearing is often more disabling than one with a definite lesion and should always be removed. This is my opinion.

(*Comment.*—I have used the long parapatellar incision in the doubtful case only. Routinely I use the short Jones incision. When it is necessary to remove the posterior part of a torn cartilage, I favor a separate incision rather than the Bosworth incision.

The procedure of putting a tenotome into the posterior portion of the knee, even though it be visualized through the anterior incision, is dangerous and not to be recommended.

Weight-bearing as early as possible is desirable but should seldom be allowed under two to three weeks.)

4. *Operative Statistics and Disposition*

In one series of 100 cartilage operations, there were ten times as many injured internal cartilages as external and five cysts. In a series of 30 arthrotomies, 26 per cent were performed for osteochondritis dissecans and 46 per cent for internal cartilage derangements; 60 per cent of the cartilages showed bucket handle tears. In another series of 64 cartilages, there were 2 cysts, 13 bucket handle tears, 24 anterior tears, 3 medial tears, 14 posterior tears, 2 longitudinal tears, 2 hypermobile cartilages, and 2 anteriomedial tears.

Little information on the final disposition of the patients was reported. In a series of 64 patients, only 1 was given a discharge.

(*Comment.*—It is my opinion that only a very small percentage of patients with knee operations are discharged from the Army, although the percentage of patients who are completely asymptomatic and able to perform full military duty is low.)

5. *Miscellaneous Conditions*

a. Osteochondritis Dissecans.—Mention was made of the frequency with which osteochondritis dissecans was encountered at operation, but few statistics on the number of cases or the operative results were reported. In one series of thirty knee operations, eight disclosed evidence of osteochondritis dissecans.

b. Pellegrini-Stieda Disease.—There were numerous reports of Pellegrini-Stieda disease. Two officers reported that three patients treated by operative removal of the calcification had shown symptomatic improvement. Another officer stated that after operative removal the knee should be immobilized for several weeks to prevent a recurrence. Two physicians reported good results following x-ray therapy.

6. *Recurrent Dislocation of the Patella*

Recurrent dislocation of the patella was reported in only one conference. One medical officer reported five cases in which the patients had been operated upon with good results.

7. *Osgood-Schlatter Disease*

Osgood-Schlatter disease was mentioned frequently. Several officers had found that it was necessary to excise loose fragments of bone about the tibial tuberosity in order to relieve the pain in that area.

PART XI. CONDITIONS INVOLVING THE FOOT

The problem of treatment of the painful foot in the Army is of great importance. The statement, "An Army is no better than the feet it marches on" is not so applicable to the Army Air Forces as to the infantry of the Army Ground Forces; however, all newly induced personnel in the Army Air Forces have to undergo the same rigid basic training as do infantry soldiers, and for this they require good feet.

1. *Incidence*

Statistics from one large infantry camp in the South show that from 0.3 to 1.0 per cent of its troop strength had foot complaints. This, of course, is not a large proportion of the troops, but it is sufficiently great to constitute a major medical problem. It is reported from two station hospitals, that 40 and 50 per cent of the orthopedic cases are foot problems.

2. *Foot Hygiene and Inspection*

In many conferences there was a discussion of foot hygiene. The questions of proper socks, blisters, toenails, foot powder, and inspection

of the feet after long marches were all subjects of discussion in many conferences. One officer was of the opinion that examination of the feet should always be included in the monthly physical inspection of all troops.

(*Comment.*—Too little attention is paid to the minor complaints of the foot, such as blisters, ingrowing nails, etc. A regular inspection of the feet of all soldiers after long marches should be carried out, preferably by the medical officer. This would decrease greatly the number of days that are lost from duty by soldiers who are required to be on their feet a large part of the time.)

3. *Fitting of Shoes*

From evidence presented at these conferences it is apparent that the proper fitting of shoes to the painful and deformed foot and even the fitting of the normal foot has not been done in a uniformly satisfactory manner. As a result, many normal feet have become painful because of the wearing of improperly fitted shoes, and many painful feet have become more painful. It was stated that after a few months of training, the length of the foot often gradually increases, and the shoe which originally may have fit satisfactorily becomes too small. It was further stated that: (1) the original shoe should be at least one-half to one size longer than the foot measurements indicate; (2) in general the shoe should be two sizes larger than that used in civilian life; and (3) care should be taken that the first metatarsophalangeal joint is at the widest part of the shoe.

Reference was made repeatedly to the Munson last for shoe fitting. This last was developed by a Colonel Munson in World War I. The Munson last includes 249 sizes, each size having a separate last. If time is taken to use the last correctly by having the soldier find the proper size for his feet, the correct fit can always be obtained. The Brannock shoe-measuring apparatus was mentioned in several of the conferences as being the type now most often used in the Army.

Several suggestions regarding the way to "break in" new shoes were made at the conferences. A method frequently used in World War I but seldom employed now is to have the recruit walk through water with his new shoes on and then march until his feet and shoes are dry. The inside of the shoe will then be definitely shaped to the form of the foot.

4. *Arch Supports*

At all conferences there was considerable discussion of the type and value of arch supports. In spite of such statements as, "any soldier who needs an arch support will not make a good soldier," and, "a rigid support will not be effective in the Army," most officers believed that arch supports have a place in the treatment of certain types of arch strain and relaxation. In several of the clinics, chiropodists (in one infantry camp as many as eight) are being employed to make very satis-

factory arch supports out of the leather and hard piano or saddle felt supplied by the quartermaster. At two of the conferences there was a discussion regarding the Morton type of anterior arch support. This comes forward under the first metatarsal head as well as behind the other four metatarsal heads. Morton stated many years ago that most people with complaints referable to the anterior portion of the foot have a short first metatarsal bone. One clinic had made an x-ray study of the length of the metatarsal bones in a series of patients with metatarsal symptoms and had found short first metatarsal bones in 16 per cent.

The use of cork insoles made by the Archograph machine was discussed at many conferences. At one field as many as 1,700 pairs were being supplied each month. The opinion was repeatedly expressed that these supports were not suitable for Army use because they do not stand up under the strain of long marches. Instances of partial disintegration of the support after one long march were cited.

The only reference to exercises for flat feet was made by one officer who doubted very much the value of foot exercises for the soldier.

(*Comment.*—It is very doubtful whether the soldier with the old flat foot which is beginning to be painful in military activity will become symptom-free and remain so with arch supports, exercises, and physical therapy, unless he be given work which involves a minimum of strain on his feet. This change of occupation within the Army is at times a very difficult thing to accomplish. Because it has often been impossible to make such a change, many soldiers have been separated from the service unnecessarily.)

5. *Rehabilitation*

One hospital reported a special rehabilitation program for soldiers with flat feet. This consisted of arch supports, special foot exercises, and gradually increasing periods of marching and drilling. The soldiers usually continued this program for three to four weeks. Many were able to return to full duty who otherwise might have been discharged from Service.

At one field a forced exercise battalion under strict medical supervision had been organized for all types of malingerers. In this group there was a high percentage of soldiers with flat feet. Many soldiers had been rehabilitated by this means.

6. *Surgery of the Foot*

At nearly every conference it was stated that the foot of the soldier should be subjected to as little surgery as possible. There were numerous reports of soldiers who were unable to return to full duty and whose conditions became worse after bunion operations. One officer expressed the opinion that the only operations indicated on the soldier's foot are those for hammer toes, overriding of the little toe, bunionettes, and soft corns. A second officer reported poor results from the amputation of

hammer toes and condemned this procedure. A third officer was of the opinion that in hammer toe the affected joint should be resected, while a fourth stated that hammer toes in military personnel should not be operated upon. Two officers reported successful plastic operations for overlapping fifth toes.

One officer made a plea that more attention be paid to ingrowing toenails. He reported that in his hospital one patient per thousand troops on the field per month had been operated upon for this condition with an average hospital stay of thirteen days, and that ingrowing toenails constituted from 10 to 20 per cent of all foot disorders.

(*Comment.*—After seeing so many unsatisfactory results from foot surgery in the Army, I am more convinced than ever that this type of surgery should be kept to a minimum among military personnel.

It appears that the incidence of ingrowing toenails on the field from which the report came is high. It is believed that most hospitals are not seeing so large a number as this.)

7. *Certificate of Disability Discharge for Flat Feet*

Apparently many certificates of disability discharges are being given because of flat feet. One camp reported 70 a week, while another reported 70 for flat feet of a total of 200. At a large Negro camp, at the time of the conference, 40 certificates of disability discharge a week were being given for flat feet. This is to be contrasted with the statement made at one conference, that from 1935 to 1940, in the regular Army, there was not given a single certificate of disability discharge for flat feet.

This discussion on certificates of disability discharge for flat feet led in each instance to consideration of malingering and exaggeration of symptoms. It was the opinion of many officers that soldiers with flat feet rapidly develop a psychoneurotic state. Statements such as the following were made:

> "Flat foot is a mental disease and not a physical one."
>
> "No certificates of disability discharge for flat feet in our hospital, but certificates of disability discharge for flat feet and psychoneurosis."
>
> "Foot complainers may be psychiatric and have a conversion neurosis."
>
> "Flat foot soldiers should be looked after by the morale builders of the Army and not by the doctors."

One officer was of the opinion that all foot cases should be "screened" to rule out psychoneurosis. If one were found, the soldier should be given a certificate of disability discharge. In contrast with this, a medical officer who had been in the German Army in World War I stated that no attention had been paid to the soldier who complained of flat feet.

(*Comment.*—Unfortunately, too many soldiers know that an extreme flat foot does not meet the minimum physical standards for induction into Service. If the soldier with flat foot is not happy in the work he is doing, his physical condition becomes exaggerated in his own mind and he is soon using it as an excuse for wanting to get out of the Service. When one soldier is given a certificate of disability discharge for flat feet, others will invariably appear with the same condition and ask for a discharge. Boards meeting to decide on this problem should exercise the utmost discretion.)

8. *Miscellaneous*

There was a discussion of what to do with plantar warts. One officer reported from 50 to 80 per cent cures with x-ray therapy. A second officer reported successful surgical treatment, two elliptical incisions being used.

Several patients with multiple painful hyperkeratoses of the feet were reported. Each of these was given a certificate of disability discharge.

Pes cavus was the subject of frequent discussion. Some officers were of the opinion that it was very difficult to treat in the Army and that the patient should be given a certificate of disability discharge, whereas others believed that with the proper arch pads, shoes, and limited exercise the feet could be made comfortable and the soldier retained in Service.

At one large basic training center, a great number of cases of tenosynovitis of the foot and lower part of the leg were reported. These patients had been successfully treated by injection with procaine and rest.

Review of Recent Meetings

REPORT OF THE 1944 MEETING OF THE SECTION ON SURGERY, GENERAL AND ABDOMINAL, OF THE AMERICAN MEDICAL ASSOCIATION

GEORGE D. LILLY, M.D., MIAMI, FLA.

THE Surgical Section of the American Medical Association convened in the ballroom of the Sherman Hotel in Chicago, Ill., on the afternoon of June 14, 1944. The chairman, **Frederick A. Coller**, Ann Arbor, Mich., presided, and **Alton Ochsner**, New Orleans, served as secretary.

George D. Lilly, Miami, Fla., presented a paper in which emphasis was placed upon the fact that even aged persons suffering from far-advanced arteriosclerotic vascular impairment of the lower extremities may be greatly benefited by interrupting the sympathetic nerve supply to the involved extremities.

Surgical removal of the lumbar sympathetic ganglia was recognized as the most desirable procedure, but Dr. Lilly advocated the use of alcoholic injection of the lumbar sympathetic ganglia in those patients whose general condition prohibited major surgery. He reported a series of his own cases in which alcoholic injection had been employed with gratifying relief of early gangrene, claudication, and night cramps. A detailed description of the injection technique was presented.

Keith S. Grimson, Durham, N. C., reported his experiences with studies regarding the effect of various sedation tests on experimental neurogenic hypertension. He concluded from his observations that such sedation tests, when employed in the preoperative study of clinical cases of essential hypertension, were of definite value in selecting suitable cases for thoracicoabdominal paravertebral sympathectomy. He emphasized the fact that all such tests may be misleading, and that some patients who did not respond to sedation obtained a worth-while lowering of their blood pressure following a radical sympathectomy.

I. A. Bigger, Richmond, Va., reported twenty-nine cases of traumatic arterial aneurysm and arteriovenous fistulas, and called attention to the fact that the present war would produce a much greater incidence of this type of pathology. He discussed the various technical problems and presented detailed reports of his more interesting cases.

Geza De Takats of Chicago presented a study of *The Causalgic State in Peace and War.* He called attention to the importance of considering causalgia before making a diagnosis of hysteria. The neurophysiology of causalgia was reviewed in detail, and treatment was discussed. The importance of early diagnosis was stressed, and forty-five of his cases were analyzed.

Arthur W. Allen, Boston, Mass., reported that the incidence of postoperative phlebothrombosis and subsequent pulmonary embolism was extremely high in New England, especially during the winter months. During 1925, there was an incidence of 3 deaths per 1,000 operations, caused by postoperative pulmonary embolism. During 1943, this incidence was reduced by 75 per cent. The reduction

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was brought about by early recognition of phlebothrombosis in the deep veins of the lower extremities, and prompt ligation of the deep femoral vein. Dr. Allen expressed the opinion that the vein ligation should be bilateral in most cases because the thrombosis is so frequently bilateral. He stated that the surgical staff of the Massachusetts General Hospital is now ligating some veins preoperatively as a prophylactic procedure in old, debilitated patients.

Burrill B. Crohn of New York presented an appraisal of the results of surgery in the treatment of regional ileitis. He analyzed the results in a series of 164 cases. Dr. Crohn's opinion, after observing the treatment of this disease for twelve years, is that simple ileotransverse colostomy cured just as many cases as the more radical procedures and involved a much lower mortality. He feels that early diagnosis and operation is most important, and that chemotherapy is of no value in this disease.

Rawley M. Penick, Jr. of New Orleans considered the problems involved in the treatment of congenital megacolon. He reviewed a series of thirty patients treated in New Orleans. He concluded that patients with megacolon should first be treated conservatively. Those who do not improve with medical treatment should be treated by left lumbar sympathectomy. If this does not afford relief the right lumbar sympathetics should be removed; and those who do not respond to this must be subjected to colectomy.

Thursday, June 15, officers for 1945 were elected. **Lieutenant-Colonel Daniel C. Elkins,** Atlanta, Ga., was selected as chairman, and **William Andrus,** New York, N. Y., was elected vice-president. **Alton Ochsner** was re-elected secretary.

Carl Bearse of Boston made a plea for early surgery in all patients with gallstones. He pointed out that early removal of the diseased gall bladder, with its stones, prevented many later complications such as common duct obstruction, pancreatitis, and acute cholecystitis. He compared the gall bladder containing gallstones to a time bomb set to do damage at an indeterminable time.

The chairman's address, presented by **Frederick A. Coller,** was one of the outstanding presentations of the meeting. Dr. Coller offered a critical analysis of his experiences with blood loss during surgery. He showed that blood loss is the greatest single factor in surgical shock, especially when associated with emotional exhaustion and surgical trauma. Emphasis was placed upon the fact that shock is much easier to prevent than to treat once it has developed, and the best way to prevent its development is to anticipate blood loss in advance and replace it as it is lost during the course of the operation, rather than using it to combat shock after it develops. Dr. Coller presented statistics showing the average blood loss in various types of surgical procedures, and called attention to the fact that blood loss in small patients is much more serious because of the relatively small total volume in such individuals. He showed that the usual clinical laboratory methods for estimating blood loss are unreliable, and that the only safe procedure is to accept the average blood loss as reported in the medical literature as a criteria as to the amount of blood which should be given during surgery. He pointed out that the average patient can manufacture only about 25 c.c. of blood daily, and that for this reason blood replacement will shorten convalescence and reduce complications and morbidity.

Warren H. Cole of Chicago stressed the potential dangers of nontoxic nodular goiter. He found that 16 per cent of the nontoxic nodular goiters were malignant. A correct preoperative diagnosis was made in only 20 per cent of these patients. Five-year cures were obtained in only 20 per cent of those patients in whom the goiter was diagnosed preoperatively, and in only 40 per cent of those in whom it was diagnosed at the time of operation, while 60 per cent of those in whom goiter

was not suspected until diagnosed microscopically were living and well five years after surgery. This is a strong argument for routine removal of all nontoxic adenomas.

Forrest O. J. Young, of Rochester, N. Y., reported his experiences with the use of plasma-thrombin as a "suture" material. He claimed three advantages for this material: the elimination of foreign body sutures, quicker wound healing, and its particular value in those patients who do not form their own fibrin. He stated that this material has been standardized and is nontoxic when used locally. He described in detail the procedure for its use.

Frank E. Adair presented a report of the clinical effects of surgical and x-ray castration in mammary cancer. He concluded that there is little or no choice between the two procedures. He observed that one-third of the surgical group had ovarian metastasis at the time of surgery, indicating a natural attempt at self-castration. He observed that the result of castration was spectacular in cases of breast malignancy in males.

Willard H. Parsons, Vicksburg, Miss., reported five cases of plasma cell mastitis. He commented upon the striking resemblance of this disease, which was first reported by Adair, to carcinoma of the breast, and discussed its differential diagnosis.

On the third day there was a joint meeting with the section on gastroenterology and proctology.

A. H. Aaron, Buffalo, N. Y., presented a paper dealing with the medical aspects of inflammatory lesions of the stomach and duodenum. Dr. Aaron called attention to the fact that peptic ulcer ranks high as a causative factor in the rejection of recruits for military service, and presented a plea for earlier diagnosis and a better plan for medical management of these ulcers.

Frank H. Lahey of Boston discussed the surgical aspect of peptic ulcer. He pointed out that all patients should receive adequate medical management and that only medical failures should be subjected to surgery. He discussed in some detail various technical problems in connection with the surgical treatment of this disease.

The second symposium of the day dealt with inflammatory lesions of the small intestines.

Henry L. Bockus, Philadelphia, Pa., discussed the medical aspect. He considered the problems presented by chronic stenosing regional enteritis. He feels that anxiety and emotional immaturity are etiologic factors, and thinks that food poisoning may play a part in the origin of this disease. He has found that the bowel lymphatic structures are involved early and always. Dr. Bockus is inclined to favor radical resection in extensive enteritis, but thinks that the exclusion operation is probably best in the average case. He has found that some of these conditions respond nicely to conservative medical management. He has found penicillin of no value, and has had no good results from vaccines and sera. He feels that the prognosis must be in doubt for many years, because remissions or recurrences may appear at any time.

Henry W. Cave of New York discussed the surgical aspect of segmental enteritis. Twenty-three patients with this disease were operated upon in the Roosevelt Hospital during the last ten years. Seven had appendectomy only. All of these did well and have had no more trouble. Dr. Cave feels that this indicates that the acute disease may subside without becoming chronic. He prefers ileocolostomy with exclusion in those cases requiring operation.

Inflammatory lesions of the colon was the final subject for discussion.

J. Arnold Bargen, Rochester, Minn., discussed the medical aspect of this subject. Dr. Bargen urged that ulcerative colitis be regarded as a syndrome rather than as a definite disease entity. He divided ulcerative colitis into the following etiologic groups: Streptococcic, tuberculosis, amoebic, lymphopathy venereum, and bacillary dysentery. Idiopathic colitis is reserved for a small group of nonspecific cases of colitis of unknown cause and atypical clinical findings. Dr. Bargen described in detail the differential diagnoses of these types of the disease.

Thomas E. Jones of Cleveland discussed the surgical aspects of inflammatory lesions of the colon. He called attention to the frequency of x-radiation stricture of the bowel, which is often overlooked as a diagnostic possibility. He considered ulcerative colitis and discussed the surgical complications, such as perforation, hemorrhage, pseudopolyposis, and the rare malignant degeneration. Diverticulosis was reviewed.

TWENTY-FIFTH MEETING OF AMERICAN ASSOCIATION FOR THORACIC SURGERY

CHICAGO, ILL., MAY 5-6, 1944

F. C. FISHBACK, M.D., WASHINGTON, D. C.

CORROSIVE Stricture of the Esophagus, Ralph Adams, Boston.—**Dr. Adams** presented two cases, the first of mediastinitis, following esophagoscopy of the stricture and treated by mediastinotomy, with gastrostomy eight days later, and subsequently successfully dilated over a thread. The second case was that of a 29-year-old woman with a stricture of seven years' duration following ingestion of a corrosive substance, for whom life with a gastrostomy became intolerable. Through a right transpleural incision, a mid-esophageal, cordlike stricture, 2 cm. in length, was exposed, and with esophagoscopes in the stomach and mouth, a dilator was guided through the stricture, and then a string washed through. The esophagus was torn by the aspirator in the lower scope, but the rent was closed, and dilatations were begun thirty-five days after operation with good results. There are four common points of stricture formation, namely, the cricopharyngeal pinchcock, the aortic crossing, the left primary bronchial crossing, and the cardia. He urged that the patient be made to swallow a thread promptly and that the thread be replaced from time to time to prevent breakage. Hydrostatic dilatation over a thread is safe, and retrograde dilatation is safer than through the mouth. Other treatments have been gastrostomy alone, resection of stricture with anterior thoracic esophagoplasty (cosmetically and functionally unsatisfactory), or resection of stricture with end-to-end anastomosis. The diagnosis of mediastinitis is based on the history of pain in the shoulder and/or upper abdomen, increased respiratory rate, fever and moderate leucocytosis, and the x-ray picture, showing restricted motion of the diaphragm and clouding of the inferior pulmonary angle. He warned against delay due to the seeming improvement eighteen to twenty-four hours after perforation.

The Management of Benign Tumors of the Esophagus, Stuart Harrington, Rochester, Minn.—Benign tumors of the esophagus are infrequent, present meager symptoms, often attaining considerable size without presenting severe symptoms, and are potentially malignant. They fall into two categories: (1) Mucosal, which are often pedunculated, usually fibrolipomas, and may regurgitate into the mouth if the stalk is long enough, and have been treated by snaring through the mouth or through cervical or transthoracic esophagotomy; (2) Extramucosal tumors are

Papers pertaining to war surgery and thymectomy have appeared in the August, 1944, issue of The Journal of Thoracic Surgery.

usually leiomyomas, do not obstruct, but may cause pain due to spasm. Surgery is usually not urgent, but when indicated is extensive.

The Causes of Mortality Following Radical Resection of the Esophagus for Carcinoma, John Garlock, New York.—**Dr. Garlock** reported sixty-six cases of tumors of the lower third of the esophagus (adenocarcinoma), with thirty-one patients operated upon and fifteen of them recovering, and sixty-five cases of tumors of the middle and upper third of the esophagus (squamous-cell carcinoma) with twenty-nine patients operated upon and sixteen recovering, presenting in all sixty operated cases with an operative mortality of 49 per cent. He emphasized: (1) The need for the utilization of a secure method of suturing the anastomosis; (2) Employment of a left transthoracic esophagogastric anastomosis for cancer of the lower half of the esophagus, with preliminary exploration and jejunostomy. He cautioned against gastrostomy because it immobilizes the stomach. (3) He advocated the Torek operation for the tumors of the middle and upper third. (4) He urged preservation of the blood supply of the stomach, and fixation of the intrathoracic portion of the stomach to the diaphragm. Nerve involvement indicates inoperability; furthermore, a very careful check should be made for nodes especially on the rectal shelf and in the supraclavicular region. The duration of dysphagia does not correlate with the degree of operability. The operative deaths were due to pulmonary and cerebral emboli, coronary disease, and pneumonia.

In the discussion of these papers, certain points were emphasized, namely, surgical excision of benign strictures was desirable where possible, and where the resected stricture was short, anastomosis was easy and fairly safe. Whether to bring up the stomach as such or as a preformed gastric tube, or to utilize the jejunum in reconstructing the esophagus were mentioned. The jejunum is more easily mobilized then the stomach and its blood supply is best six feet distal to the ligament of Treitz. The stomach, however, can be brought up as high as the superior mediastinum and its circulation is definitely superior to that of the jejunum. For benign strictures, operation is indicated only when the stricture is not dilatable.

Current Observations on Thoracic Surgery in the Present War, Michael E. DeBakey, New Orleans.—The mortality from chest wounds has fallen since the Civil War when it was 51.4 per cent, and from World War I, when it was 37 per cent, to about 27 per cent in World War II. In the present war, chest wounds comprise about 8 per cent of all wounds. Mortality and the incidence of infection are higher after wounds from shell fragments than from bullets. In previous wars, penetrating wounds exceeded nonpenetrating wounds, but in this war because of the utilization of mines, bombs, and torpedoes, nonpenetrating wounds of the chest are more frequent.

War Wounds of the Chest Observed at the Thoracic Surgery Center, Walter Reed General Hospital, Major Brian Blades, Washington, D. C.—All shell fragments should be removed if they are causing symptoms. The size and position of the fragments within the chest are factors for consideration. Some have to be removed because of the patient's knowledge of their presence and his ensuing fear and anxiety. Open thoracotomy is now safe, simply incising the lung and removing the foreign body. Lobectomy is not necessary or even desirable. Empyema has been exceedingly rare in Major Blades' experience. Draining sinuses are usually the result of a foreign body, necrosis of cartilage, or osteomyelitis of a rib. Of 107 patients with hemothorax, 77 were well by the time they arrived at Walter Reed, 24 were cured by aspiration, and only 6 required operation, namely, thoracotomy and decortication. Of these 6 none were very sick and none had a pneumothorax, and this apparently benign character of the injury was

probably responsible for the delay in aspiration. Blood left in the thorax may produce fibrothorax. Air replacement should be condemned and the aim of treatment should be prompt and complete re-expansion of the lung to obliterate the pleural space and abate the menace of empyema. When discharged, none of these patients had dyspnea or a reduced vital capacity. Chest wall pain sometimes followed and may have been due to pericostal sutures, which are not necessary.

Trends and Practices in Thoracic Surgery in the Mediterranean Theatre, Colonel Edward D. Churchill, Consulting Surgeon Allied Force Medical Section.—Attention is now being focused on the lung rather than the pleural space, as in the last war. Physiologic disturbances of intrathoracic physiology are corrected immediately, with reduction in shock, infection, and morbidity. Hemorrhage from the chest wall into the pleural space is aspirated and used for autotransfusion. Sucking wounds of the chest wall are no longer sutured, but are closed with tight petrolatum gauze compresses. Tension pneumothoraces are rare; the air is vented. A catheter with a flutter valve may be used for the tension pneumothorax. "Wet lung" is treated by bronchial aspirations, oxygen, and novocain block of the intercostal spaces to release bronchospasm and permit painless coughing. Thoracotomy is rarely done. There remains a divergence of opinion as to the indication for thoracotomy; it should be done only with a precise aim in view, since it may delay re-expansion of the lung. Thoracotomy done five to ten days after injury may prevent infection. Hemothorax should be treated by repeated aspirations but after the fourth week they tend to become static. High explosive fragments produce continued bleeding with deposition of plasma and red blood cells in the pleural space.

These cases should be appraised by the fifth or sixth week and if the fibrin envelop persists, thoracotomy and decortication should be done to prevent fibrothorax. Air replacement is not done except for continuing hemorrhage and then thoracotomy is preferable. Patients with asymptomatic foreign bodies are returned to duty; if the foreign body produces dyspnea, it is removed.

Discussors brought out the facts that if air replacement were done at all, it should be done within the first twelve hours; that when the bleeding was from the chest wall, air replacement was obviously useless; that the aim should be complete aspiration and early re-expansion of the lung; that empyema does not occur if the chest is left dry; that if blood is left behind, fibrothorax will ensue and the patient will become a respiratory cripple. The excellence of the care of the wounded men before being brought to the army thoracic centers was commented on.

Difficulties in the Differential Diagnosis of Bronchogenic Carcinoma, R. G. Bloch, and W. E. Adams, Chicago.—Extensive x-ray surveys have revealed an increasing number of unsuspected intrathoracic neoplasms. In 15,000 x-ray examinations at the University of Chicago Clinic, 91 neoplasms were discovered: 34 (or 37 per cent) were metastatic carcinoma, 25 (or 27 per cent) were primary pulmonary carcinoma, 19 (or 21 per cent) were lymphomas, 5 were sarcomas, 1 dermoid, 1 neurofibroma, and 1 hemangioma (last group, 14 per cent). Thirteen per cent of the early bronchogenic carcinomas were peripheral and beyond the reach of the bronchoscope for diagnosis.

Bronchial Adenoma, C. L. Jackson, Philadelphia.—**Dr. Jackson** presented twenty bronchial adenomas. Fourteen occurred in women (70 per cent). The age incidence ranged from 13 to 52 years, with predominance in the second and third decades. Hemoptysis and cough were the common symptoms. All diagnoses were based on bronchoscopic biopsies. The histologic criteria were (1) epithelial proliferation with a peculiar stroma, (2) "packed" cells with pyknoses, (3) absence of mitotic figures, (4) a resemblance to fetal lung, (5) glandular pattern not always evident. These tumors at times seem to regress; incomplete re-

moval does not accelerate their growth rate, and malignant change is uncommon. Seventeen of these patients were treated bronchoscopically, the tumor being removed with forceps or by coagulation. Three were treated by pulmonary resection.

The Problem of So-called Adenoma of the Bronchus, Evarts Graham, and N. A. Womack, St. Louis.—The term "adenoma" connotes a benign tumor. **Dr. Graham** recalled his earlier paper on the subject in which he stated that these tumors were potentially malignant, that they were derived from mesoblastic as well as epithelial elements, that they resembled fetal developmental abnormalities, and possessed invasive properties. Other authors had also reported such tumors undergoing malignant degeneration. Brunn and Goldman had suggested in 1940 that these bronchial tumors which became malignant be termed "papilloma" instead of adenoma. These tumors do not ulcerate; their cell structure is characterized by pleomorphism and they resemble persistent fetal lung buds. Congenital anomalies tend to become malignant and such anomalies are associated with bronchial adenomas. That only a few have been found at necropsy may be due to their having replaced their adenomatous characteristics with those of malignancy. They usually lie close to the carina, in a main stem bronchus. Radical resection was advised. Lobectomy was usually impossible in light of their common location. Bronchoscopic removal has been done on some, but with worry and concern on the part of the surgeon as to the ultimate fate of the patient.

In the discussion, **Harold Brunn** advised bronchoscopic removal before lung resection, and added that when death occurred it was not due to the tumor, but to infection distal to the tumor. **Ralph Adams** cited 17 adenomas at the Massachusetts General Hospital, out of a series of 174 lung tumors; 5 of these were removed bronchoscopically, 1 was found at autopsy, and 11 were treated by pulmonary resection with but 1 death. In contrast to these figures, he said that out of the 28 patients with bronchogenic carcinomas resected, only 3 (11 per cent) were living. Planography has been helpful in demonstrating the invasiveness of these tumors. **John Alexander** (Ann Arbor) said that these adenomas are grade 1 carcinomas. In their series at the University of Michigan, they have had 13 such cases, two of which showed metastases. In one instance, a medullary carcinoma, grade 3, was found in a metastatic gland. **Dr. Jackson** closed, saying that these adenomas arise chiefly at bronchial spurs; that the sequelae of bronchial obstruction were the real cause of trouble; that they show no inherent tendency to malignancy, and that accurate pathologic diagnosis is essential. Cell structure may and does vary in different parts of the same tumor. **Dr. Graham** closed his remarks by saying that an adenoma might metastasize to a lymph gland without being malignant; but that while it shows no mitoses, and grows slowly, it is invasive, and potentially malignant, comparing it with a mixed tumor of the parotid which might exist twenty years before undergoing malignant change. He cited eight cases of adenomas which showed regional or distant metastases.

An Attempt to Evaluate the Effects of Thymectomy in the Treatment of Myasthenia Gravis, Alfred Blalock, Baltimore.—The knowledge of the relationship of the thymus to myasthenia gravis is meager and vague. Thymic tumors have been found in about one-half the cases of myasthenia gravis. The prostigmine test is important in diagnosis; the optimum dose must be determined before operation. Patients do have spontaneous remissions, making it difficult to evaluate the benefits of the operation. The rationale of the operation is based on the cure of myasthenia gravis in 1936 by the removal of a thymic tumor. It was subsequently tried where no tumor was present. He advised the use of an intratracheal catheter, very little ether, local anesthesia, and a median sternotomy. Of 20 patients operated on, 4 have died, 3 showed little or no improvement, 5 moderate improvement, 5 considerable improvement, and 3 may be regarded as

well. The more severe the myasthenia gravis, the greater likelihood of benefit from thymectomy. If a thymic tumor is present, it should be removed. Thymectomy is indicated if the patient is disabled, even though there is considerable risk. Prior to the use of prostigmine, 70 to 80 per cent died; 22 out of 100 patients died, when treated with prostigmine. There is no way to predict the improvement to be expected from the operation, except that the shorter the preoperative disability, the better the results have been. X-ray treatment was useless in the absence of a thymic tumor. It would appear that other factors are involved besides the thymus.

Indications for Pericardiotomy With Special Reference to Exposure of the Infected Patent Ductus Arteriosus, Harold Neuhof, New York.—**Dr. Neuhof** advocated a transpleural pericardiotomy as simpler and safer, except in the presence of infection. Aside from the usual indications, he advocated its use for obscure manifestations suggesting low-grade pericardial infection, for determining the existence of any residual after drainage for suppurative pericarditis, also occasionally to discover the extent of hilar invasion in carcinoma of the lung and to decompress tamponade-producing effusions. More particularly the transpleural approach offers better exposure for ligation of the patent ductus arteriosus in cases of bacterial endocarditis. In the discussion, **Stuart Harrington** also endorsed the posterolateral approach, saying that it gave better exposure and greater ease in controlling possible hemorrhage, should it occur. **J. C. Jones** did not recommend opening the pericardium in ligating the patent ductus because the pericardial fluid obscures the operative field; he said also that cutting the fibrous attachments to the aorta lengthens the ductus and facilitates its ligation.

Arteriovenous Fistula of the Lung, John C. Jones, Los Angeles.—Arteriovenous fistula of the lung is a rare lesion which presents a clear-cut clinical entity, consisting of cyanosis, clubbing of the fingers and toes, polycythemia, a normal heart, and increased blood volume with decreased oxygen saturation. Planography is helpful when a bruit is absent. He presented a case of a 24-year-old white woman with a red count of 6½ to 7½ million, hemoglobin 130 per cent, blood pressure 112/94, clubbing of the fingers, a murmur over the tumor mass, and x-ray pictures showing "tumor of the right lung" and "dilated vessels to middle lobe." A pneumothorax of five months' duration did not collapse the tumor, and did cause dyspnea and mediastinal herniation. When pneumonectomy was done, no transfusion was given because of the polycythemia.

In the discussion, **Robert M. Janes** reported three cases, one of which was bilateral, with operation and recovery. Ligation of the branch of the pulmonary artery to the involved lobe was suggested, but **Dr. Jones** thought this would be ineffectual in controlling the shunt.

Hydatid Disease of the Lung, Louis R. Davidson, New York.—The presence of our troops in countries where hydatid disease of the lung is prevalent is going to account in the future for its more frequent occurrence in this country. Although echinococcus infestation involves the liver in from 75 to 90 per cent of the cases, cyst formation in the lung occurs in about 10 per cent. Diagnosis is based on an eosinophilia (usually over 4 per cent), complement fixation test (unreliable, giving false positives), skin test (Casoni), and sputum examination for hooklets and scolices. The cysts should not be punctured for diagnosis. These lung cysts have three layers, an inner, germinal layer, a middle layer or laminated membrane, and an outer layer or adventitia, representing a connective tissue reaction. In x-ray, these cysts appear round, homogeneous and sharply outlined, and often a crescentic space appears within the cyst, which may be pathognomonic. Treatment consists of a two-stage thoracotomy, eradication of the cyst at the second stage,

and treating the cyst bed with 2 per cent formalin. In the discussion, **Leo Eloesser** suggested that lobectomy should shorten convalescence and reduce possible complications.

Studies of the Pathogenesis, Dynamics and Closure of Tension Cavities, H. M. Riggins, and R. P. Gearhart, New York.—Tuberculous cavities result from liquefaction and expulsion of caseous material. All bronchi communicating with cavities are diseased. Behavior of cavities depends on whether the bronchus is open or closed. Rapid enlargement of tension cavities had often been observed without corresponding caseation and liquefaction of lung tissue. Clinically, tension cavities exhibit wheezing, fever, and varying amounts of sputum; symptoms are often aggravated at the menses due to bronchial swelling. By means of transthoracic needling, done only through an obliterated pleural space, it was found that in a cavity with a closed bronchus, there was a positive pressure; when more air is injected, the pressure rises and remains elevated, and when air is aspirated, the pressure remains negative. Gas analysis showed a low oxygen content with a closed bronchus, and atmospheric oxygen when the bronchus was open. The tubercle bacillus was always present in cavities; the presence of another organism was variable. Tension cavities behave unpredictably.

The Determination and Treatment of Pressure Cavities in Pulmonary Tuberculosis, A. M. Vineberg, and W. E. Kunstler, Montreal.—**Vineberg and Kunstler** found that a large percentage of tuberculous cavities were ''tension'' cavities and were rarely closed by thoracoplasty. The detection of these cavities can only be accomplished by needling and recording intracavitary pressures. Intracavitary suction drainage will reduce such cavities to the size of the catheter, but permanent closure requires partial thoracoplasty. Negative pressure cavities close readily with thoracoplasty. Suction drainage and thoracoplasty afford the ideal treatment for closure of tension cavities. With giant cavities, they advocated an anterior thoracoplasty prior to suction drainage.

An Evaluation of the Monaldi Suction Drainage of Tuberculous Pulmonary Cavities, J. R. Head, Chicago.—The Monaldi procedure may be useful in both tension and nontension cavities. Head employed it in patients with low vital capacity and to reduce the size of extremely large cavities. It should not be used if other accepted methods of treatment are applicable. Under local anesthesia, he makes a small anterior intercostal incision, puts in a pack, closes it, and later after the formation of adhesions, inserts a catheter.

In discussing this group of papers, **John Alexander** said that the Monaldi procedure rarely closes a cavity and that a large percentage of cavities are *not* tension cavities. Thoracoplasty *does* close many tension cavities. The present tendency is to fewer rib thoracoplasties with dropping in of the scapula, to preserve as much sound lung as possible. The abolition of the inspiratory excursion in the collapsed lung removes the cavity distending factor. **E J. O'Brien** stated that from 80 to 90 per cent of all cavities were closed by pneumothorax or thoracoplasty. If a cavity required drainage, he preferred open drainage to the Monaldi method. **Leo Eloesser** said, ''This discussion proves that we don't know what we're doing when we operate on tuberculosis.'' He preferred the term ''blocked cavity'' to ''tension cavity,'' but would compromise on ''insufflation cavity.'' Cavities, he said, were caused by two factors, (1) insufflation, which is intermittent, part-time, and pertains only to round cavities, and (2) extrinsic factors, such as caliber of the communicating bronchus, the character of the surrounding lung, and extremely involved aerodynamic factors. Insufflation cavities demonstrate that positive pressure exceeds negative pressure within them most of the time. In closing, **Dr. Riggins** emphasized that pneumothorax fails in positive pressure cavities. **Dr. Vineberg** said that in

Canada, 30 per cent of cavities persist after thoracoplasty and that cavity drainage reduces the amount of surgery and avoids the sacrifice of good lung for adequate collapse.

Pulmonary Resection in the Treatment of Tuberculosis: Introductory Remarks, F. S. Dolley, Los Angeles.—**Dr. Dolley** emphasized the need for precise indications and criteria of satisfactory results. In general, lung resections for tuberculosis have gone too far, often because of the difficulty in selecting the correct cases. Cases suitable for less radical surgery should be excluded. The usual complications after resection are extension and/or contralateral spread, empyema, and bronchial fistula with positive sputum.

Total and Partial Pneumonectomy in the Treatment of Pulmonary Tuberculosis, R. M. Janes, Toronto.—**Dr. Janes** reported 15 cases of pneumonectomy, with 48 per cent mortality, done because of bronchial stenosis, and 16 partial pneumonectomies (7 in upper lobes and 9 in lower lobes) with 25 per cent mortality. These latter were unusually difficult when the cavity was close to a fissure. He employed a posterolateral approach and individual ligation technique; and closure was with pericostal sutures because they enhanced the comfort of the patient by immobilizing the ribs adjacent to the operative field.

Lobectomy in Pulmonary Tuberculosis, H. C. Maier, New York.—**Dr. Maier** reported 16 cases of lobectomy done in the past one and one-half years, and excluded all cases in which previous operations had been done, as well as those in which an accidental finding of tuberculosis occurred. The risk is not so great when individual ligation technique is used, along with improved anesthesia and appropriate pre- and postoperative care. His indications were: (1) in certain cases, in anticipation that collapse therapy might fail, (2) in some where there was no definite contraindication to thoracoplasty, (3) the lesion situated at a site, unfavorable for collapse therapy, (4) tension cavities where pneumothorax had failed, (5) bronchial tuberculosis, (6) lower lobe cavities, (7) extensive cavitation, limited to a single lobe, (8) shrunken lobe, (9) unilateral disease in a young patient where thoracoplasty might give poor result. He felt that modern anesthesia should prevent contralateral spread. He used a posterolateral incision. There were 12 cases of upper and middle lobe lobectomy, and 4 lower lobe operations. Dissection from the chest wall may be very difficult; in fact may cause abandonment of the operation. He covered the bronchial stump with a pleural flap. Completion of fissures was often difficult. Time was saved by working slowly, the average time of operation being five hours. The average fall in blood pressure was only 13 mm. mercury (the greatest being only 25 mm.), and transfusions of 1,000 c.c. of blood were given during operation. Drainage was carried out for twenty-four to forty-eight hours. Ten patients had uneventful postoperative courses; 3 were uneventful except for increased density in the opposite lung which cleared later; 1 had an apical empyema (staphylococcus); 1 had a tuberculous empyema with bronchial fistula and will require a later thoracoplasty; and finally 1 death occurred a month after operation from extensive spread to the opposite lung. Of the 15 survivors, 12 had negative sputa, 2 had positive sputa, and 1 is too recent to evaluate. Thoracoplasty was done later in 1 case.

Primary Upper Lobectomy Versus Modern Selective Thoracoplasty in the Treatment of Tuberculosis, J. M. Chamberlain, Oneonta, N. Y.—Years ago, the aim in treatment of tuberculosis was apparently obesity; later it became sputum conversion (bacteriologic cure), and now it is sputum conversion plus rehabilitation of the patient. Endobronchial tuberculosis is always present when there is a cavity. With bronchial obstruction, there may be emphysema, atelectasis, and tension cavities. Control of the parenchymal focus controls the endobronchial tuberculosis. The degree of emphysema is proportional to the size and extent of

the lesion. The status of the remaining lung tissue is quite as important as sputum conversion. The functioning alveolar units and the bellows action of the chest must be preserved, and if lobectomy produces a compensatory emphysema, it harms the remaining lung. The principles of treatment are: (1) drainage, (2) immobility, (3) relaxation, (4) compression, and (5) resection. Thoracoplasty satisfies these criteria in the following order, namely, No. 3, 4, 1 and 2. Respiratory function after thoracoplasty may be unchanged, increased, or decreased. Upper lobectomy to control a major focus produces overdistention of the remaining lung, especially the alveoli, and is less physiologic than selective thoracoplasty, which preserves the oxygenating function of the remaining lung tissue by preventing alveolar distention. Since lobectomy produces alveolar distention and poor function, it should be used secondarily, in the event of failure of thoracoplasty. The following tabulation represents some of the results quoted by those discussing these papers:

PNEUMONECTOMY	LOBECTOMY	TOTAL	DEAD	DOCTOR
12	9	21	6	C. P. Bailey, Philadelphia
?	?	35	20	R. H. Sweet, Boston
		97	21 (22%)	Wilson, Boston
10	3	11	Not given	J. R. Davidson, New York
3	5	8	2	S. O. Freedlander, Cleveland

Dr. Sweet's figures were from the Massachusetts General Hospital. **Dr. Wilson** was quoting **Dr. Overholt's** results. If one is able to clamp the bronchus first, it may prevent contralateral spread. **E. J. O'Brien** conceded that while lung resection is less hazardous than formerly, it is responsible for spreads and empyemas. He felt that lung resections do produce compensatory emphysema, while thoracoplasty preserves good lung tissue. Bronchostenosis is not a contraindication to thoracoplasty since such stenoses may be dilated before and after thoracoplasty. **John Alexander** said of the newer procedures, such as the Semb apicolysis (often complicated by subscapular infection), expraplеural pneumothorax, Monaldi and lung resection, that each may have its place, but that they should not be used where thoracoplasty would be effective. In case of doubt, it is best to err on the side of conventional collapse therapy because the risk is less. The newer procedures may be done successfully and still leave a positive sputum. The risk of a spread after lung resection is still considerable. **John Strieder** summed up the indications for lobectomy as (1) tuberculoma, (2) tuberculous bronchiectasis, (3) tension cavities, and (4) bronchostenotic lesions. **S. O. Freedlander** gave an additional indication for lobectomy, namely, compression of an upper lobe bronchus by extrabronchial tuberculous glands. In closing, **Dr. Dolley** asked the personal question as to whether any of the audience would have a lung resection for tuberculosis, and then summed up the indications as he saw them, namely (1) cavities near the mediastinum (unlikely to be closed by thoracoplasty), (2) tension cavities after thoracoplasty, and (3) progressive bronchostenosis. **Dr. Janes** wondered whether the effect of overdistention of the remaining alveoli was as bad as depicted. **Dr. Maier** said that after lobectomy for bronchiectasis, there is little change in lung function; and also that the immediate postoperative pleuritic reaction masks true lung function. **Dr. Chamberlain** asked us to focus our attention on the remaining lung, and emphasized the fact that emphysematous lung tissue was functionless even though it appeared normal by x-ray. He said that bronchial peristalsis is lost after upper lobectomy and that there is decreased bronchial motility after any lung resection, making tuberculous spreads easier.

The Use of Whole Blood Transfusion in Resections of the Lung, W. E. Adams, and T. F. Thornton, Jr., Chicago.—Large citrated blood transfusions may cause citrate intoxication. Referring to **John Gibbon's** paper on fatal pulmonary edema at the Toronto meeting, produced by very large and rapid transfusions after bilateral lobectomy in cats, **Dr. Adams** said that the possibility of pulmonary edema depended on (1) the amount of lung resected, (2) the amount of blood given (it never occurred with 15 c.c. per kilogram, the equivalent of one liter per 70 kg. in man), (3) the rate of administration, and (4) overtransfusion. Blood may be given to replace any operative loss without producing pulmonary edema. Blood should be replaced as it is lost and not after first giving plasma or glucose. Blood loss is usually underestimated; it will usually average 1,500 c.c. for lobectomy or pneumonectomy.

Studies in Oleothorax, P. D. Crimm, Evansville, Ind.—Tuberculous empyema is the result of rupture of subpleural tuberculous focus by ulceration. The infected pleura cannot be chemically disinfected without doing more harm than good. Peanut oil and cod liver oil are irritating; they inhibit the growth of the tubercle bacillus and produce exudates that seal the ruptured foci. The oil must cover the entire pleura until pleural thickening occurs. These oils stimulate an obliterative pleuritis. Should the lung fail to re-expand, a less extensive Schede will be required. By the use of oleothorax, aspirations are less frequent.

Notices

TO AID WAR EFFORT, AMERICAN COLLEGE OF SURGEONS CANCELS 1944 CLINICAL CONGRESS

The American College of Surgeons, upon action of its Board of Regents, has canceled its Annual Clinical Congress because of the acute war situation that has developed, involving greater demands than at any time in the past upon our transportation systems for the carrying of wounded military personnel, troops, and war materiel The Congress was to have been held in Chicago, Ill., Oct. 24 to 27.

Dr. Irvin Abell of Louisville, Ky., chairman of the Board of Regents, in making the announcement, said that this action was taken after consultation with officials in Washington, D. C. Some of the replies which were received from these officials read in part as follows:

From Major General Norman T. Kirk, Surgeon General, United States Army:

> Naturally, we all like these meetings to be held and to attend them. However, from an official standpoint I must say we are needing more and more railroad transportation to move our battle casualties from the ports to our hospitals. And there are still many troops in the United States who require railroad transportation to ports in order to get them overseas. In addition, difficulty is being experienced in obtaining the necessary materiel to continue the battle. This means transportation for the raw materials that go into munitions and the shipping of these munitions to the ports after they are fabricated. Each month the need for this material overseas is increasing rather than diminishing.
>
> The war is far from won and I think we should all consider the war effort rather than the satisfaction of our individual desires. That should give us the answer. After seeing the bomb craters and destroyed homes, factories, and transportation facilities in Europe, I am not surprised that this nation feels it is far removed from war and that the war is about over. It isn't.

From R. H. Clare, assistant director, passenger section, division of traffic movement, Office of Defense Transportation:

> This office cannot attempt to evaluate the importance or the essentiality of any particular meeting. We have attempted to portray clearly the present critical transportation situation. The transportation requirements of the Armed Forces are not at present being entirely satisfied. At the same time, soldiers and sailors on leave from duty overseas are unable to secure Pullman accommodations to their homes and frequently have to stand in coaches for considerable distances. The responsibility, therefore, rests upon the officers of your organization to determine if, in the light of these conditions, you should go through with your Chicago meeting.
>
> I believe you will agree that the Office of Defense Transportation cannot attempt to make this decision for you. We assure you that there is an urgent need for the curtailment of convention travel in order to clear the transportation channels of the country for the movement of military and essential civilian travel. We, therefore, ask for your serious consideration of our appeal in the light of this situation.

Feeling that the many factors in favor of holding the Clinical Congress, however important, are less vital than the assurance of adequate transportation and the best medical care for the wounded, as well as the clearance of transportation facilities as far as possible for the conveying of troops and war materiel, the American College of Surgeons willingly cancels, for the third successive year, its annual meeting, in order to aid the war effort. The Regents recognize that there is a great burden on the members of the surgical profession in their local communities as the result of the large proportion of the profession which is serving with the Armed Forces. They also take cognizance of the desire of the profession to do nothing which would interfere with the successful prosecution of the war program, such as would be caused by the temporary absence of its members from duties during the period of the Congress. More than 3,000 surgeons and some 2,000 hospital representatives usually attend the Clinical Congress.

At the annual meeting of the Board of Regents which will be held later in the year, fellowship in the College will be conferred *in absentia* on the class of initiates of 1944, as there will be no convocation exercises. At the same time the list of hospitals, cancer clinics, medical services in industry, hospitals conducting programs of graduate training in surgery, and medical motion pictures, that meet the College standards, will be approved and later published.

All present officers, regents, governors, and standing committees will continue in office.

War conditions permitting, the Clinical Congress will be held in the fall of 1945.

THE ASSOCIATION OF MILITARY SURGEONS OF THE UNITED STATES

Office of the Chairman of the Convention and Program Committees, Governors Island, New York, N. Y.

Addresses by the nation's three surgeons general, the chief of the Veterans Administration, the commanding general of the Second Service Command, and New York City's mayor will highlight the fifty-second annual meeting of the Association of Military Surgeons of the United States at the Hotel Pennsylvania, New York, N. Y., Nov. 2 to 4, 1944.

Other features of the meeting, which is being arranged under the direction of Colonel Lucius A. Salisbury, association president, and Colonel Charles M. Walson, chairman of the convention and program committees, will be forum lectures, discussion panels, military and commercial scientific exhibits, and medical motion pictures.

Expected to participate in the forums and discussions are: Major General Norman T. Kirk, Surgeon General, U. S. Army; Admiral Ross T. McIntire, Surgeon General, U. S. Navy; Surgeon General Thomas F. Parran, U. S. Public Health Service; Major General David D. W. Grant; Rear Admiral Luther Sheldon; Major General G. Brock Chisholm of Canada; Brigadier Generals Frank T. Hines, James S. Simmons, Charles C. Hillman, Raymond W. Bliss, Fred W. Rankin, Hugh J. Morgan, and Stanhope Bayne-Jones; Dr. Warren F. Draper, U. S. Public Health Service; Dr. Chester Keefer of Boston; and Dr. R. E. Dyer, National Institute of Health.

Forum lectures will cover war surgery, chemotherapy, communicable diseases, neuropsychiatry, medical problems in theaters of operation, dental rehabilitation, and equine encephalitis.

Topics for discussion panels, which will be integrated with the lectures, are: War Wounds, Burns, and Fractures, Neuropsychiatric Problems, Treatment and Prevention of Venereal Diseases, Penicillin and Sulfonamide Therapy, Orthopedic and Reconstruction Therapy, Neurosurgical Problems, Tropical Diseases in the Army and Navy, and Aviation Medicine.

Separate discussions have also been arranged for Dental, Veterinary, Sanitary and Medical Administrative Corps officers.

Colonel Frederick H. Foucar, of the Second Service Command Laboratory, is chairman of the committee arranging the scientific exhibits, which will include material from Army, Navy, and Veterans Hospitals, the Carlisle Barracks Medical Field Training School, many medical depots, and the Office of the Army Surgeon General. All available space for the technical exhibits of commercial firms was disposed of months ago.

Major General Norman T. Kirk, Surgeon General of the Army and honorary chairman of the fifty-second annual meeting of the Association of Military Surgeons, which will be held at the Hotel Pennsylvania, New York, N. Y., Nov. 2 to 4, 1944, inclusive. (U. S. Army Medical Museum.)

The annual banquet, which is to be addressed by a prominent speaker representing the Army, will be held November 3, and an entertainment is planned for the night of November 2. The banquet speech and the speeches of the Surgeons General and the Veterans Administrator will be broadcast nationally, while "spot" broadcasts will probably be made by several of the principal forum speakers.

Other committee chairmen for the meeting are: Brigadier General Ralph G. DeVoe, M.C., reception; Lieutenant Colonel Howard F. Baer, Sn.C., entertainment; Lieutenant Colonel Ralph E. Ladue, A.U.S., reservations; Colonel George W. Hinman, Jr., public relations; Mrs. Norman T. Kirk (honorary) and Mrs. Lucius A. Salisbury, women's hostess.

The registration desk will open November 1. Lieutenant Colonel R. E. Ladue, 52 Broadway, New York 4, N. Y. (HA. 2-5200), should be notified of any difficulty encountered in securing rooms through the Hotel Pennsylvania.

Book Reviews

Physical Foundations of Radiology. By Otto Glasser, Ph.D., Professor of Biophysics and Head of Department of Biophysics, Cleveland Clinic Foundation, Cleveland, Ohio; Edith H. Quimby, Sc.D., Associate Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York, N. Y.; Lauriston S. Taylor, Ph.D., Chief of X-Ray Section, National Bureau of Standards, Washington, D. C.; and J. L. Weatherwax, M.A., Philadelphia General Hospital and Graduate School of Medicine, University of Pennsylvania, Philadelphia, Pa. Pp. 426. New York, 1944, Paul B. Hoeber, Inc.

Presented in a readable, easily understood, concise form, the general principles underlying the use of radiation for medical purposes are here set forth.

This small volume contains a brief description of the history of radiology, of the nature of radiation, the character of x-ray apparatus, and means of production of x-rays. The application of roentgen rays to diagnosis and therapy is briefly discussed. The methods of measurement, both of x-rays and radium, are elaborated. The theories of radioactivity and the uses of radium are briefly presented. Protective measures against the deleterious effects of radiation are discussed in some detail. The authors are all pre-eminent in their respective fields. The book can be highly recommended to anyone using roentgen or radium radiation as a well-written authoritative introduction to the subject.

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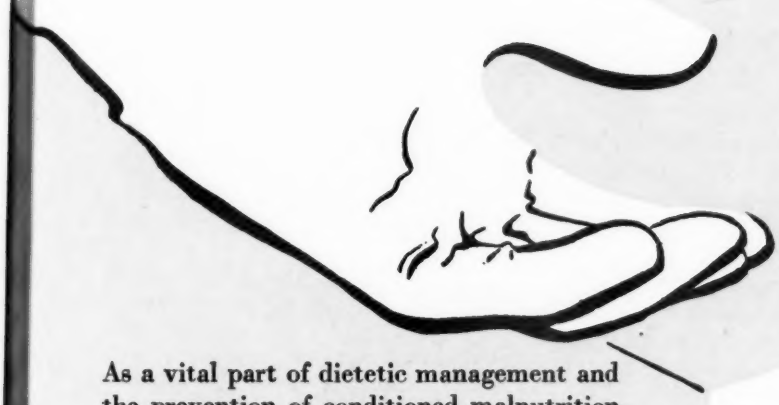

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